

(19) World Intellectual Property Organization  
International Bureau



(43) International Publication Date  
7 November 2002 (07.11.2002)

PCT

(10) International Publication Number  
**WO 02/089479 A2**

(51) International Patent Classification<sup>7</sup>: H04N 7/10, 7/173

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(21) International Application Number: PCT/IB02/01359

(22) International Filing Date: 17 April 2002 (17.04.2002)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:

0110272.2 26 April 2001 (26.04.2001) GB  
60/345,661 2 January 2002 (02.01.2002) US

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(81) Designated States (national): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, OM, PH, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZM, ZW.

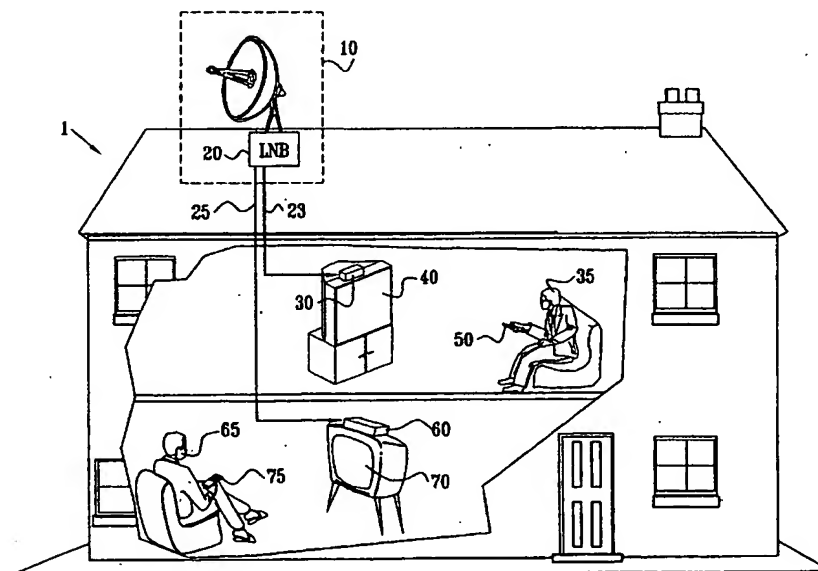
(84) Designated States (regional): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— without international search report and to be republished upon receipt of that report

[Continued on next page]

(54) Title: HOME NETWORK SYSTEM



(57) Abstract: An audio visual content server including a content storage unit operative to store audio and / or video content, a content transmission unit including a modulator and operative to receive digital signals including encoded audio and / or video content and to transmit modulated signals to at least one receiving device, and a tuner unit operative to: receive input signals including encoded audio and / or video content; and output the received signals to the content storage unit for storage therein, wherein the content transmission unit receives the signals at least from the content storage unit. Related apparatus and methods are also described.

REF. 5 DOCKET P4040066  
CORRES. COUNTRY: \_\_\_\_\_  
COUNTRY: PCT

WO 02/089479 A2

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## HOME NETWORK SYSTEM

### FIELD OF THE INVENTION

The present invention relates to television systems in general, and in particular to television systems including a personal video recorder (PVR).

### BACKGROUND OF THE INVENTION

5 Systems for scrambling a television data stream are well-known in the art. One such system is described in the following US Patents: 5,282,249 to Cohen et al.; and 5,481,609 to Cohen et al. Scrambled television data streams described in the Cohen et al patents comprise both scrambled data representing  
10 television signals and coded control messages, also known as ECMs. The ECMs of Cohen et al comprise, in a coded form, data necessary for generating a control word (CW) which may be used to descramble the scrambled data representing television signals. An ECM is also termed a control word packet or CWP.

While the two patents to Cohen et al describe an analog system, that  
15 is, a system in which analog television data streams are broadcast to television sets, it is appreciated that similar ECM methods may also be used for digital television data streams. Generally, the scrambling techniques used for scrambling analog television signals such as, for example, the well-known "cut-and-rotate" technique, are chosen for their applicability to analog signals. In scrambling of  
20 digital television signals other scrambling techniques, well-known in the art, are used, the techniques being more appropriate to digital signals such as, for example, applying the well-known DES algorithm to the digital television signals.

Methods of transmitting a scrambled digital signal, are described in the MPEG-2 standard, ISO/IEC 13818-6, 12 July 1996 and subsequent editions.

25 The ARIB standard is described at:

<http://www.arib.or.jp/arib/english/>

In general, methods of transmitting a scrambled digital signal, including ECMs, are well known. Some systems use a composite signal, that is, an analog or digital signal including a plurality of components. Typically the  
30 plurality of components includes both a scrambled television signal component and an ECM component, the ECM component comprising a plurality of ECMs. Prior art references which discuss examples of this type of signal include the

following: DVB ETR289, "Digital Video Broadcasting (DVB): Support for use of scrambling and conditional access (CA) within digital broadcasting systems"; and DVB SIM061, "Technical specification of DVB-Simulcrypt", 1 April 1997.

Other documents relating to broadcasting of digital information include the DVB Specification for Data Broadcasting, document SI-DAT 360 (TM 1779), 12 February 1997; and ATSC Digital Television Standard, document A54, October 1995 and subsequent editions.

Other methods of transmitting a scrambled digital signal, particularly useful in a case where the signal includes sub-signals encoded according to various different methods, are described in "Common Interface Specification for Conditional Access and other Digital Video Broadcasting Decoder Applications", DVB document A017, May 1996 and subsequent editions; and in "Common Interface Specification for Conditional Access and other Digital Video Broadcasting Decoder Applications", CENELEC EN50221:1997.

PCT Patent Application PCT/GB02/00030 of NDS Limited describes an STB in a subscriber unit of a combined digital television and communication system, the STB including a controller and a QAM based tuner operatively controlled by the controller to selectively enable shared use of the QAM based tuner between the following two functions: tuning to a digital television frequency, and providing a downstream cable-modem link.

Published PCT Patent Application WO 00/01149 of NDS Limited describes a digital television recording method including broadcasting a television program, operating an agent for determining whether to record the program, storing the program, and retrieving at least part of the program for display. Access to predetermined portions of the program may be determined by a user set of parameters. The program may be edited to include the user set of parameters, which then may be stored as part of the program.

Reference is now made to Fig. 1, which is a simplified partly pictorial, partly block illustration of a typical prior art home entertainment system.

Fig. 1 shows a prior art home entertainment system 1, comprising a satellite dish 10 which comprises a low noise block down-converter (LNB) 20. A first LNB output 23 feeds a transport stream to a set top box (STB) 30. The set

top box 30 presents elements of the transport stream as a television program which is presented at the request of a first user 35 on a television 40. The first user 35 enters requests via a first remote control 50.

A second LNB output 25 feeds a transport stream to a Personal  
5 Video Recorder (PVR) 60. The PVR 60 presents elements of the transport stream as a television program which is presented at the request of a second user 65 on a television 70. The second user 65 enters requests via a second remote control 75.

The PVR 60 can also record television content, to be viewed later, on a hard disk (not shown) inside the PVR 60, as is well known in the art and as is  
10 described, for example, in Published PCT Patent Application WO 00/01149.

In prior art home entertainment systems, content stored on the PVR 60 is inaccessible to STBs in the same home. Thus, for example, the STB 30 cannot access content stored in the PVR 60.

In the prior art home entertainment system 1, users can only interact  
15 with content stored on the hard disk inside the PVRs on televisions that are functionally linked with PVRs. If there are additional televisions in the house which are functionally linked to televisions via STBs, those televisions are only enabled with the functionality that the corresponding STBs provide, and none of the functionality which is specific to the PVR.

20 US Patent 5,936,660 to Gurantz describes a digital video converter box for use in a home with multiple television sets; the system of Gurantz does not include PVR functionality, nor does Gurantz suggest use of PVR functionality.

Published PCT Patent Application WO 97/35140 of News Datacom  
25 Limited describes a method of implementing two or more conditional access (CA) smart cards in which the two smart cards are used in two decoders in a home entertainment system. The first smart card is operative, upon insertion in a first slot in a first card reader, to activate decoding of the pay television transmissions in the first decoder. The second smart card is operative upon insertion in a second  
30 slot in the second card reader, to activate decoding of the pay television transmissions in the second decoder. The second smart card is operable to deactivate in accordance with predetermined criteria, and to reactivate upon

insertion in the first slot in the first card reader after removal of the first smart card from the first card reader.

A home server system is described at:

<http://www.moxi.com/multi-room.htm>

- 5           The present application claims priority from GB Provisional Patent Application 0110272.2 and US Provisional Patent Application 60/345,661 which describe home entertainment systems and the disclosures of which are hereby incorporated herein by reference.

- 10           The disclosures of all references mentioned above and throughout the present specification are hereby incorporated herein by reference.

## SUMMARY OF THE INVENTION

There is a real business desire to find an elegant, cost effective solution to allow the user to simultaneously view multiple digital pay-TV channels in the home.

5           A user able to watch multiple digital channels could be willing to pay additional revenue to the platform operator for this service. The aim of platform operators is generally to grow their revenue per home.

          Metrics which gauge the size of the viewer audience, for example viewer audience as reflected in BARB figures and Nielsen ratings, will increase  
10   for digital channels if more than one channel can be viewed at once within the same home. This will result in greater advertising revenues for the digital channels.

          The potential of higher viewing figures could attract new channels for carriage by the platform operator making the platform operator's service  
15   offering more attractive.

          The introduction of PVRs into existing subscriber homes provides the ideal opportunity to satisfy the needs expressed above. The cost-effective solution of the present invention, in preferred embodiments thereof, not only allows the simultaneous viewing of multiple digital pay-TV channels, but also  
20   provides access to PVR functionality at multiple locations in the home, thereby providing enhanced revenue opportunities for the platform operator.

          The present invention seeks to provide an improved home entertainment system. The present invention includes methods, apparatus, user interfaces, and related elements. Persons skilled in the art will appreciate, for  
25   example, that when user interfaces are mentioned, related methods are also appreciated to exist and to be contemplated as part of the present invention; when apparatus is mentioned, related methods are appreciated to exist and to be contemplated as part of the present invention; and so forth.

          It is believed that the present invention, in preferred embodiments  
30   thereof, would be particularly useful in a home; however, it is appreciated that the present invention may also be used in other places, such as public buildings.

Without limiting the generality of the foregoing, the various embodiments of the present invention are described herein with reference to use in a home.

Furthermore, it is believed that the present invention, in preferred embodiments thereof, would be particularly useful for delivery of entertainment; however, it is appreciated that the present invention could also be used for delivery of any appropriate video, audio, or audio-visual content. Without limiting the generality of the foregoing, the various embodiments of the present invention are described herein with reference to delivery of entertainment.

A major flaw with conventional digital satellite pay-TV is the inability of users to watch multiple digital channels at the same time. This inability can result in conflict in many homes when there is a demand to watch more than one digital channel at the same time. In a worst case scenario this inability can result in people canceling premium subscription channels due to the lack of opportunity within the home to view them.

To be able to view multiple digital channels in an existing system, the user requires multiple set top boxes (STBs). Many platform operators subsidize the STB cost to encourage the take up of their pay-TV service, but are unlikely to subsidize more than one STB per home.

For the user to independently add a second STB the user needs to pay the unsubsidized purchase price of the box plus the cost of converting their satellite dish to have a multiple output LNB, since an LNB output is required in the prior art for each STB. Such a cost is prohibitive for many.

The user who does make the investment in a second STB may not wish to pay double the primary subscription price just to be able to simultaneously watch multiple channels.

The platform operator may wish to offer secondary subscriptions at reduced rates. However this opens up the possibility of lost revenue for the platform operator if neighboring users have separate STBs but share the cost of primary and secondary subscriptions. To make this scenario more difficult some proposals include a physical interconnect between master and slave CA smart cards. Such a solution can complicate the wiring around the home.



The present invention is directed, in preferred embodiments thereof, to providing an improved home entertainment system for television which addresses the above-mentioned issues.

In some preferred embodiments of the present invention, a four  
5 output LNB delivers a transport stream to a maximum of four tuners in a home entertainment system, typically comprising, but not limited to: a PVR with two tuners; and two STBs. All four LNB outputs may pass through the PVR in order to give the STBs at least limited access to content which is stored on the PVR.

The PVR's tuners are utilized to record live television content or to  
10 view live television content. The PVR preferably does not need to utilize a tuner to play back content stored on the storage device of the PVR. When the STB sends a request to play back content which is stored on the storage device of the PVR, content is sent from the PVR to the STB via the tuner of the STB. The stored content, ECMs and relevant data are preferably remultiplexed into a  
15 standard MPEG-2 transport stream. The remultiplexed signal is then modulated according to a digital television standard modulation such as QPSK, QAM, OFDM, 8VSB (as are well known in the art and as specified by the DVB, ATSC, ARIB or DSS) and mixed with a carrier signal generated by a local oscillator. The clients that receive the remultiplexed remodulated transport stream may be any  
20 appropriate type of client including DVB-S, DVB-C, and DVB-T set top boxes, PCs or televisions.

The modulated signal may preferably be inserted into the L-band  
feed by, for example, using a combiner or switch or directional coupler. Alternatively, the modulated signal may preferably be inserted into the L-band  
25 internal or external to the PVR box. Alternative preferred embodiments include topologies that deliver the local PVR signal to a separate point so that the local PVR signal is combined to the L-band path to the slave STB at some location other than in the PVR box, for example near the satellite dish or in the attic for simplified in-home wiring.

30 The above-mentioned remultiplexed modulated signal from the PVR can then be interpreted by the STBs in the same manner that a live broadcast stream would be interpreted by the STBs. The incoming live broadcast and the

above-mentioned remultiplexed modulated signal may preferably be combined together before delivery to the home entertainment system's associated STBs.

Alternatively, in the case of a four output LNB, the maximum number of tuners in the home entertainment system may comprise any of the

5 following, for example:

1. Two tuners operatively associated with a two-tuner PVR and one tuner operatively associated with a STB;

2. Two tuners operatively associated with a two-tuner PVR and two tuners each respectively operatively associated with one of two STBs;

10 3. A tuner operatively associated with a one tuner PVR and a maximum of three tuners operatively associated with a maximum of three STBs.

In an alternative preferred embodiment of the present invention, the four outputs of the LNB can be configured to reconstruct the transmitted television signal, with each output corresponding to a different quadrant of the  
15 signal. This preferred embodiment would enable the television system to support more than four tuners in the home entertainment system.

It is appreciated that the present invention is not limited to particulars of the preferred embodiments discussed; in particular, the present invention is not limited to systems with a four output LNB and could, for  
20 example, be used with an LNB having more than four outputs.

There is thus provided in accordance with a preferred embodiment of the present invention an audio visual content server including a content storage unit operative to store audio and / or video content, a content transmission unit including a modulator and operative to receive digital signals including encoded  
25 audio and / or video content and to transmit modulated signals to at least one receiving device, and a tuner unit operative to: receive input signals including encoded audio and / or video content, and output the received signals to the content storage unit for storage therein, wherein the content transmission unit receives the signals at least from the content storage unit.

30 Further in accordance with a preferred embodiment of the present invention the content transmission unit also includes a remultiplexer, and the content transmission unit is operative to transmit remultiplexed modulated signals.

Still further in accordance with a preferred embodiment of the present invention the remultiplexer includes a piecewise linear remultiplexer.

Additionally in accordance with a preferred embodiment of the present invention the modulator includes a QPSK modulator.

5 Moreover in accordance with a preferred embodiment of the present invention the modulator includes a QAM modulator.

Further in accordance with a preferred embodiment of the present invention the modulator includes a OFDM modulator.

10 Still further in accordance with a preferred embodiment of the present invention the modulator includes a 8VSB modulator.

Additionally in accordance with a preferred embodiment of the present invention the at least one receiving device includes a plurality of receiving devices.

15 Moreover in accordance with a preferred embodiment of the present invention the content transmission unit further includes a switching unit operative to output the signals to one or more of the plurality of receiving devices.

Further in accordance with a preferred embodiment of the present invention the switching unit receives a control input and the switching unit outputs the signals to one or more of the plurality of receiving devices based, at least in  
20 part, on the control input.

Still further in accordance with a preferred embodiment of the present invention the content transmission unit also receives the signals from an external source.

25 Additionally in accordance with a preferred embodiment of the present invention the content transmission unit receives the signals only from the content storage unit.

Moreover in accordance with a preferred embodiment of the present invention the tuner unit includes a plurality of tuners operative to receive input signals including encoded audio and / or video content and to output the received  
30 signals to the content storage unit for storage therein.

Further in accordance with a preferred embodiment of the present invention the input signals include control data.

Still further in accordance with a preferred embodiment of the present invention at least a portion of the control data is delivered to the receiving device.

5 Additionally in accordance with a preferred embodiment of the present invention the control data includes at least one of the following: at least one EMM, and system information.

Moreover in accordance with a preferred embodiment of the present invention the control data is delivered in band.

10 Further in accordance with a preferred embodiment of the present invention the control data is delivered out of band.

Still further in accordance with a preferred embodiment of the present invention the receiving device includes a set top box.

Additionally in accordance with a preferred embodiment of the present invention the receiving device includes a DVB-S compliant set top box.

15 Moreover in accordance with a preferred embodiment of the present invention the audio visual content server has remultiplexing and / or modulation parameters which are DVB-S compliant.

20 Further in accordance with a preferred embodiment of the present invention the audio visual content server has remultiplexing and / or modulation parameters which are not DVB-S compliant.

Still further in accordance with a preferred embodiment of the present invention the receiving device includes a DVB-C compliant set top box.

25 Additionally in accordance with a preferred embodiment of the present invention the audio visual content server has remultiplexing and / or modulation parameters which are DVB-C compliant.

Moreover in accordance with a preferred embodiment of the present invention the audio visual content server has remultiplexing and / or modulation parameters which are not DVB-C compliant.

30 Further in accordance with a preferred embodiment of the present invention the receiving device includes a DVB-T compliant set top box.

Still further in accordance with a preferred embodiment of the present invention the audio visual content server has remultiplexing and / or modulation parameters which are DVB-T compliant.

5 Additionally in accordance with a preferred embodiment of the present invention the audio visual content server has remultiplexing and / or modulation parameters which are not DVB-T compliant.

Moreover in accordance with a preferred embodiment of the present invention the receiving device includes a ATSC compliant set top box.

10 Further in accordance with a preferred embodiment of the present invention the audio visual content server has remultiplexing and / or modulation parameters which are ATSC compliant.

Still further in accordance with a preferred embodiment of the present invention the audio visual content server has remultiplexing and / or modulation parameters which are not ATSC compliant.

15 Additionally in accordance with a preferred embodiment of the present invention the receiving device includes a DSS compliant set top box.

Moreover in accordance with a preferred embodiment of the present invention the audio visual content server has remultiplexing and / or modulation parameters which are DSS compliant.

20 Further in accordance with a preferred embodiment of the present invention the audio visual content server has remultiplexing and / or modulation parameters which are not DSS compliant.

Still further in accordance with a preferred embodiment of the present invention the receiving device includes an ARIB compliant set top box.

25 Additionally in accordance with a preferred embodiment of the present invention the audio visual content server has remultiplexing and / or modulation parameters which are ARIB compliant.

Moreover in accordance with a preferred embodiment of the present invention the audio visual content server has remultiplexing and / or modulation parameters which are not ARIB compliant.

30 Further in accordance with a preferred embodiment of the present invention the receiving device includes a television.

Still further in accordance with a preferred embodiment of the present invention the receiving device includes a personal computer.

Additionally in accordance with a preferred embodiment of the present invention the first tuner receives input signals from a broadcast source.

5           Moreover in accordance with a preferred embodiment of the present invention the broadcast source includes a cable broadcast network.

Further in accordance with a preferred embodiment of the present invention the broadcast source includes a satellite broadcast network.

10           Still further in accordance with a preferred embodiment of the present invention the broadcast source includes a terrestrial broadcast network.

Additionally in accordance with a preferred embodiment of the present invention the broadcast network includes a digital broadcast network.

Moreover in accordance with a preferred embodiment of the present invention the broadcast network includes a television network.

15           Further in accordance with a preferred embodiment of the present invention the broadcast network includes a pay television network.

20           Still further in accordance with a preferred embodiment of the present invention the audio visual content server also includes a low noise block (LNB) receiving satellite signals and providing the satellite signals to the first tuner.

There is also provided in accordance with another preferred embodiment of the present invention an audio visual content server including a content storage unit operative to store audio and / or video content, a content transmission unit operative to receive signals including encoded audio and / or video content and to transmit the signals to at least one receiving device, and a tuner unit operative to receive input signals including encoded audio and / or video content, and output the received signals to the content storage unit for storage therein, wherein the content transmission unit receives the signals at least from the content storage unit, and the input signals include control data, and at  
30   least a portion of the control data is delivered to the receiving device.

Further in accordance with a preferred embodiment of the present invention the content transmission unit also receives the signals from an external source.

5 Still further in accordance with a preferred embodiment of the present invention the content transmission unit receives the signals only from the content storage unit.

Additionally in accordance with a preferred embodiment of the present invention the tuner unit includes a plurality of tuners operative to receive input signals including encoded audio and / or video content and to output the received signals to the content storage unit for storage therein.

Moreover in accordance with a preferred embodiment of the present invention and wherein the control data includes at least one of the following: at least one EMM, and system information.

15 Further in accordance with a preferred embodiment of the present invention the control data is delivered in band.

Still further in accordance with a preferred embodiment of the present invention the control data is delivered out of band.

20 Additionally in accordance with a preferred embodiment of the present invention the content transmission unit includes a remultiplexer, and a modulator.

Moreover in accordance with a preferred embodiment of the present invention the modulator includes a QPSK modulator.

Further in accordance with a preferred embodiment of the present invention the modulator includes a QAM modulator.

25 Still further in accordance with a preferred embodiment of the present invention the modulator includes a OFDM modulator.

Additionally in accordance with a preferred embodiment of the present invention the modulator includes a 8VSB modulator.

30 Moreover in accordance with a preferred embodiment of the present invention

Further in accordance with a preferred embodiment of the present invention the at least one receiving device includes a plurality of receiving devices.

5 Still further in accordance with a preferred embodiment of the present invention the content transmission unit further includes a switching unit operative to output the signals to one or more of the plurality of receiving devices.

Additionally in accordance with a preferred embodiment of the present invention the switching unit receives a control input and the switching unit outputs the signals to one or more of the plurality of receiving devices based, at  
10 least in part, on the control input.

Moreover in accordance with a preferred embodiment of the present invention the receiving device includes a set top box.

Further in accordance with a preferred embodiment of the present invention the receiving device includes a DVB-S compliant set top box.

15 Still further in accordance with a preferred embodiment of the present invention the audio visual content server has remultiplexing and / or modulation parameters which are DVB-S compliant.

Additionally in accordance with a preferred embodiment of the present invention audio visual content server has remultiplexing and / or  
20 modulation parameters which are not DVB-S compliant.

Moreover in accordance with a preferred embodiment of the present invention the receiving device includes a DVB-C compliant set top box.

Further in accordance with a preferred embodiment of the present invention the audio visual content server has remultiplexing and / or modulation  
25 parameters which are DVB-C compliant.

Still further in accordance with a preferred embodiment of the present invention the audio visual content server has remultiplexing and / or modulation parameters which are not DVB-C compliant.

Additionally in accordance with a preferred embodiment of the present invention the receiving device includes a DVB-T compliant set top box.  
30



Moreover in accordance with a preferred embodiment of the present invention the audio visual content server has remultiplexing and / or modulation parameters which are DVB-T compliant.

5 Further in accordance with a preferred embodiment of the present invention the audio visual content server has remultiplexing and / or modulation parameters which are not DVB-T compliant.

Still further in accordance with a preferred embodiment of the present invention the receiving device includes a ATSC compliant set top box.

10 Additionally in accordance with a preferred embodiment of the present invention the audio visual content server has remultiplexing and / or modulation parameters which are ATSC compliant.

Moreover in accordance with a preferred embodiment of the present invention

15 Further in accordance with a preferred embodiment of the present invention the audio visual content server has remultiplexing and / or modulation parameters which are not ATSC compliant.

Still further in accordance with a preferred embodiment of the present invention the receiving device includes a DSS compliant set top box.

20 Additionally in accordance with a preferred embodiment of the present invention the audio visual content server has remultiplexing and / or modulation parameters which are DSS compliant.

Moreover in accordance with a preferred embodiment of the present invention the audio visual content server has remultiplexing and / or modulation parameters which are not DSS compliant.

25 Further in accordance with a preferred embodiment of the present invention the receiving device includes an ARIB compliant set top box.

Still further in accordance with a preferred embodiment of the present invention the audio visual content server has remultiplexing and / or modulation parameters which are ARIB compliant.

30 Additionally in accordance with a preferred embodiment of the present invention the audio visual content server has remultiplexing and / or modulation parameters which are not ARIB compliant.

Moreover in accordance with a preferred embodiment of the present invention the receiving device includes a television.

Further in accordance with a preferred embodiment of the present invention the receiving device includes a personal computer.

5           Still further in accordance with a preferred embodiment of the present invention the first tuner receives input signals from a broadcast source.

Additionally in accordance with a preferred embodiment of the present invention the broadcast source includes a cable broadcast network.

10           Moreover in accordance with a preferred embodiment of the present invention the broadcast source includes a satellite broadcast network.

Further in accordance with a preferred embodiment of the present invention the broadcast source includes a terrestrial broadcast network.

Still further in accordance with a preferred embodiment of the present invention the broadcast network includes a digital broadcast network.

15           Additionally in accordance with a preferred embodiment of the present invention the broadcast network includes a television network.

Moreover in accordance with a preferred embodiment of the present invention the broadcast network includes a pay television network.

20           Further in accordance with a preferred embodiment of the present invention the audio visual content server includes a low noise block (LNB) receiving satellite signals and providing the satellite signals to the first tuner.

25           There is further provided, in accordance with any of the above-described preferred embodiments of the present invention, a server-based audio-visual system including the audio visual content server and a plurality of receiving devices each receiving input from the audio visual content server.

## BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will be understood and appreciated more fully from the following detailed description, taken in conjunction with the drawings in which:

5                    Fig. 1 is a simplified partly pictorial, partly block illustration of a prior art home entertainment system;

                  Fig. 2 is a simplified partly pictorial, partly block illustration of a home entertainment system, constructed and operative in accordance with a preferred embodiment of the present invention;

10                  Fig. 3 is a simplified partly pictorial, partly block illustration of a preferred implementation of a portion of the system of Fig. 2;

                  Fig. 4 is a simplified partly pictorial, partly block illustration of a preferred implementation of the system of Fig. 3;

15                  Fig. 5 is a simplified partly pictorial, partly block illustration of a preferred implementation of a portion of the system of Fig. 3;

                  Fig. 6 is a simplified partly pictorial, partly block illustration of an alternative preferred implementation of a portion of the system of Fig. 2;

                  Fig. 7 is a simplified partly pictorial, partly block illustration of a preferred implementation of a portion of the system of Fig. 6;

20                  Fig. 8 is a simplified partly pictorial, partly block illustration of an alternative preferred implementation of a portion of the system of Fig. 6;

                  Fig. 9 is a simplified partly pictorial, partly block illustration of another preferred implementation of a portion of the system of Fig. 6;

25                  Fig 10 is a simplified flowchart illustration of a preferred method of operation of the system of Fig. 2;

                  Fig. 11 is a simplified flowchart illustration of another preferred method of operation of the system of Fig. 2;

                  Fig. 12 is a simplified graphical illustration of variable bitrate with respect to time;

30                  Fig. 13 is a simplified graphical illustration of variable bitrate with respect to program clock reference;

Fig. 14 is a simplified graphical illustration of a piecewise linear approximation to the variable video bitrate of Fig. 13; and

Fig. 15 is a simplified flowchart illustration of a preferred method of producing a full rate output transport stream, useful in conjunction with  
5 various preferred embodiments of the present invention.

## DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

In the drawings of the present application, similar reference numbers are used to refer to similar elements. For the sake of brevity and clarity of description, repeated description of similar elements is generally omitted.

5 Reference is now made to Fig. 2, which is a simplified partly pictorial, partly block illustration of a home entertainment system, constructed and operative in accordance with a preferred embodiment of the present invention.

The system of Fig. 2 comprises a home entertainment system 100, located in a residence 11. The home entertainment system 100 preferably  
10 comprises:

reception apparatus such as a satellite dish 120, which preferably includes a low noise block down-converter (LNB) 130;

a personal video recorder (PVR) 140;

at least one set top box (STB) 145, comprising, in the example of  
15 Fig. 2, a first set top box (STB) 150 and a second set top box (STB) 160;

at least one display device, comprising, in the example of Fig. 2, at least one television 170, comprising a first television 180, a second television 190, and a third television 200;

and at least one control device 203, comprising a first control  
20 device 204, a second control device 205, and a third control device 206.

In Fig. 2, a satellite communications system is shown by way of example as the broadcast source, it being appreciated that any other appropriate form of transmission, including but not limited to, a cable broadcast network or a terrestrial broadcast network may also be used as a means of transmission. Digital  
25 broadcast networks, television networks, and pay television networks are also appropriate means of transmission.

In Fig. 2, the at least one control device 203 is shown as a remote control device. Remote control devices are shown by way of example only; the example is not meant to be limiting. Control devices can comprise devices  
30 mounted on the television or any other appropriate devices which can be used for controlling a television including, but not limited to, handheld remote control devices, computer mouse type controls, computer trackball type controls, cellular

phones, portable personal organizers, or control devices mounted on furniture utilized by the viewer. The at least one control device 203 may comprise different types of control devices.

5 A plurality of users 210, comprising, in the example of Fig. 2, a first user 220, a second user 230, and a third user 240, interacts with the home entertainment system 100.

The home entertainment system 100 may be located in one room or in a plurality of rooms, comprising, in the example of Fig. 2, a first room, a second room, and a third room.

10 The first user 220 uses the first control device 204 to control the first television 180 via the PVR 140. The first user 220 can view television content, including recorded television content recorded on the PVR 140.

The Low Noise Block (LNB) 130 comprises a plurality of LNB outputs 290, which includes, in the example of Fig. 2, a first LNB output 293, a  
15 second LNB output 294, a third LNB output 295, and a fourth LNB output 296.

In one preferred embodiment of the invention, for the example of a satellite communications system, each tuner, whether it is in a PVR or in a STB, is preferably operatively associated with an output from an LNB in order to be functionally enabled. Typically PVRs comprise no more than two tuners,  
20 comprising one tuner which enables the user to view a program delivered to the television, and a second tuner for simultaneously recording another program in the PVR. However, the methods described in the present invention can also be applied to a PVR comprising one tuner or more than two tuners.

25 Alternatively the LNB may provide satellite signals to a subset of tuners in the system.

In Fig. 2 the plurality of LNB outputs 290 preferably passes through the PVR 140. As described in more detail below with reference to Fig. 4, the first LNB output 293 and the second LNB output 294 are operatively associated with the tuners (not shown in Fig. 2) inside the PVR 140.

30 As described in more detail below with reference to Fig. 4, the LNB outputs that are operatively associated with the at least one STB 145 provide at least limited functionality from the PVR 140 to the at least one STB 145,

preferably including the ability to view television content that has been stored on the PVR 140, which functionality STBs in a conventional entertainment system do not have.

In Fig. 2, the third LNB output 295 and the fourth LNB output 296  
5 are operatively associated with the first STB 150 and the second STB 160 respectively.

In Fig. 2, the third LNB output 295 and the fourth LNB output 296 pass through the PVR 140. The third LNB output 295 is operatively associated with the tuner in the first STB 150 via a first two-way communication link 297.  
10 The fourth LNB output 296 is operatively associated with the tuner in the second STB 160 via a second two-way communication link 298. At least one two way communication link 299, comprising, in the example of Fig. 2, the first two-way communication link 297 and the second two-way communication link 298, links all of the set top boxes in the home entertainment system 100 to the PVR 140.  
15 The two-way communication links preferably allow user requests to be send from the STBs 150 and 160 to the PVR 140 and allow content to be sent from the PVR 140 to the STBs 150 and 160.

The second user 230 and the third user 240 are thus able to view content which has been stored on the PVR 140.

20 Alternatively, the third LNB output 295 and the fourth LNB output 296 may pass directly to the at least one STB 145 without passing through the PVR 140. In such a case, the STBs may not have PVR functionality.

The second user 230 uses the second control device 205 to control the second television 190 via the first STB 150.

25 The third user 240 uses the third control device 206 to control the third television 200 via the second STB 160.

Reference is now made to Fig. 3 which is a simplified partly pictorial, partly block illustration of a preferred implementation of a portion of the system of Fig. 2.

30 Fig. 3 shows a high level architecture that enables reuse of the existing subsidized standard STB, and any additional STBs within the home, as a slave to the PVR home server box. To avoid unnecessary physical modification

of the existing STBs the digital video path from the PVR to the slave STB is the L-band signal.

Fig. 3 illustrates a system for the delivery of television content 300 via a transmission mechanism such as the satellite dish 120. The system for the delivery of television content 300 corresponds to the home entertainment system 100 of Fig. 2.

The plurality of LNB outputs 290 is delivered to the PVR 140. The third LNB output 295 and the fourth LNB output 296 are functionally linked to two tuners (not shown in Fig. 3) inside the PVR 140; The two tuners enable the user to view one program from the PVR 140 and simultaneously record another program onto the PVR 140.

The at least one communication link 299, comprising a first communication link 297 and a second communication link 298, is operatively associated with the at least one STB 145, comprising a first STB 150, and a second STB 160.

Reference is now made Fig. 4, which is a simplified partly pictorial, partly block illustration of a preferred implementation of the system of Fig. 3.

Fig. 4 illustrates a system for the delivery of television content 400 via a transmission mechanism such as the satellite dish 120.

An architecture comprising multiple standard DVB-S clients is depicted in Fig. 4 by way of example. It is appreciated that any other appropriate client may be used, for example DVB-C or DVB-T clients.

The plurality of LNB outputs 290 is delivered to the PVR 140. The PVR 140 comprises:

- at least one PVR tuner 433, comprising a first tuner 435, and a second tuner 440;
- a storage device 445;
- a remultiplexer 455;
- a modulator, for example a Quadrature Phase Shift Keying (QPSK) Modulator 460;
- a local oscillator 465;
- a mixer 470; and



at least one combiner 473 comprising a first combiner 475, and a second combiner 480.

The first LNB output 293 delivers a transport stream (not shown) to the first tuner 435. The second LNB output 294 delivers a transport stream (not shown) to the second tuner 440. Both the first tuner 435 and the second tuner 440 preferably have the ability to store content on the storage device 445. The stored material can be retrieved from the storage device 445 and viewed on a display device, such as a television (not shown in Fig. 4), at the user's request. Conventional components enabling such retrieval and display are not shown for the sake of simplicity of description.

Two tuner PVRs are well known in the art. One particular non-limiting example of a two tuner PVR is described in PCT Patent Application PCT/GB02/00030, referred to above.

The first tuner 435 and the second tuner 440 preferably enable the user to view one program and record another program at the same time. Either tuner can be used to view live television content or to record television content onto the storage device 445. Retrieval of stored content can be done at the request of the user (not shown) who is using the PVR 140 or the first STB 150 or the second STB 160.

Each STB also comprises a tuner (not shown), as is well known in the art, which is used to view live television content

It is appreciated that, in the embodiment of Fig. 4, the STB 145 needs a tuner to play back content that has been stored on the PVR storage device 445, but the PVR 140 does not need a tuner to play back content that has been stored on the PVR storage device 445.

The first STB 150 and the second STB 160 are slaved to the PVR 140 and consequently have at least limited PVR capability as described above. In order to view content which has been stored on the PVR 140, the content stored on the storage device 445 must be processed in a way that enables the first STB 150 and the second STB 160 to interpret the content stored on the storage device 445.

If a user of an STB enters a request to view content stored on the storage device 445 via a control device, content from the PVR 140 is preferably prepared for viewing on the requesting STB.

If an STB, for example the STB 150, requests content from the PVR 140, EMMs and other data 497 are sent from a tuner, such as tuner 440 to the remultiplexer 455. The program 496 is sent from the storage device 445 to the remultiplexer 455. The remultiplexer multiplexes the program 496 and the EMMs and other data 497 together in the form of a signal, which is then sent to the QPSK modulator 460 which remodulates the signal.

System information and / or control information may be comprised in the EMMs and other data 497. An EMM, as is well known in the art, is an entitlement management message.

The broadcast EMMs are passed through to the slave box to ensure no broadcast EMMs intended for the slave box, typically for a smart card in the slave box, are missed while the slave box is tuned to the local PVR content. Other data, which may preferably include all data sent out on all channel multiplexes, is also preferably remultiplexed with the signal and EMMs. If the content is scrambled, ECMs, which are preferably required to descramble the local content, are sent either with the content itself (in band), or separately from the content itself (out of band). If the ECMs are sent with content, they are also remultiplexed into the signal.

The local oscillator 465 produces a carrier wave, which is mixed with the output of the QPSK modulator 460 by the mixer 470 to produce a signal which is of the same form as a live broadcast signal (or so close in form as to be equivalent thereto), which signal the at least one STB 145 is therefore able to process and present in the same manner in which live broadcast signals are presented.

The output of the mixer 470 is combined with the live broadcast from the third LNB output 295 by the combiner 475 to deliver a combined signal to the first STB 150.

The output of the mixer 470 is combined with the live broadcast from the fourth LNB output 296 by the combiner 480 to deliver a combined signal to the second STB 160.

Alternatively, the output of the mixer 470 may be combined with  
5 the live broadcast from the fourth LNB output 296 by the combiner 480 to deliver a combined signal directly to a suitably-equipped television or personal computer.

Thus, the first STB 150 and the second STB 160 have access to live content and to the content stored on the PVR 140 and have at least limited PVR capability.

10 Reference is now made to Fig. 5, which is a simplified partly pictorial, partly block illustration of a preferred implementation of a portion of the system of Fig. 3.

Fig. 5 depicts an out of band bi-directional implementation in which an existing RS-232 port inside a slave STB, for example the first STB 150,  
15 be used to facilitate master/slave communications between the master PVR, for example the PVR 140, and the slave STB.

The well-known and industry standard RS-232 interface is commonly provided and is a standard interface on STBs and PVRs.

A dongle modem modulates the RS 232 data comprising control  
20 requests between the slave STB and the master PVR. The dongle modem delivers the RS-232 data on a carrier wave which is out of the L-band, but which is transmitted on the L-band cable without interfering with the L-band frequencies.

The apparatus of Fig. 5 comprises a system 500 for the delivery of master/slave control messages between the PVR 140 and the first STB 150.

25 The dongle modem of Fig. 5 is a modem which is specially configured to transmit and receive control messages on L-band cables.

The dongle modem preferably comprises a RS-232 input with a data buffer. The dongle modem generates a locally generated carrier frequency. Data is preferably modulated on the carrier frequency using any suitable  
30 modulation technique, for example QPSK. At the transmission end, the modulated signal is inserted into the L-band cable using a combiner in such a way

as not to interfere with the other signals in the L-band cable. At the reception end, a tuner tunes to the carrier frequency and demodulates the data.

A plurality of dongle modems 510 comprising a first dongle modem 520 and a second dongle modem 530 are operatively associated with a plurality of RS-232 ports 540 inside the PVR 140 and the STB 150. The plurality of RS-232 ports comprises a first RS-232 port 550 and a second RS-232 port 560.

A plurality of L-band cables 570 comprising a first L-band cable 575, a second L-band cable 580, and a third L-band cable 585 is utilized to transmit L-band signals. The plurality of dongle modems 510 modulates control signals which are sent back and forth between the PVR 140 and the first STB 150.

Referring back to Fig. 2, the L-band path of 575 corresponds to the first two-way communication link 297 or the second two-way communication link 298.

Referring back to Fig. 5, requests 590, sent from the first STB 150 to the PVR 140, are an example of the control signals that can be sent on the plurality of L-band cables.

The second L-band cable 580 corresponds to the first two-way communication link 297 in Fig. 2.

A controller (not shown), which sends control signals to the system for the delivery of master/slave control messages 500, could comprise any appropriate control mechanism.

For example, the master/slave control mechanism between the PVR 140 and the first set top box 150 could be a software application on the STB that is activated by an Electronic Program Guide (EPG), EPGs being well known in the art. Alternatively the master/slave control mechanism could be activated when a local disk indicator (not shown) is set on the STB, which then communicates with a so-called "demon application" on the PVR. The demon application could preferably be in an inactive state, periodically scanning to see if the STB has sent the demon application a message indicating that the STBs local disk indicator is set.

Control data may preferably be input into the signal and transmitted in band or not input into the signal and transmitted out of band. The preferred embodiment of Fig. 5 is an example of control messages being sent out of band.

At least a portion of the control data is preferably delivered to a  
5 client STB, a client television, or a client PC.

The return path from the client STB could be used for conditional access or interactive call back. For example, if only the PVR server is connected to a phone line, the client devices are able to connect to the line via the PVR server using the return path communication.

10 In terms of other equipment not directly related to the audio visual home network, if L-band cabling were to become de facto installation within the home, then other devices, such as PCs could place carriers on the cable in an unused band for data transfer; this would be similar to data communication over the main wiring or in a home phone network.

15 Reference is now made to Fig. 6, which is a simplified partly pictorial, partly block illustration of an alternate preferred implementation of a portion of the system of Fig. 2.

Fig. 6 illustrates a system 600 for the delivery of television content to a plurality of slave STBs via a transmission mechanism such as a satellite dish  
20 120.

Fig. 6 shows an alternate high level architecture that enables reuse of the existing subsidized standard STB, and any additional STBs within the home as slaves to the PVR home server box.

Referring back to Fig. 3, the system for the delivery of television  
25 content 300 illustrates how a four output LNB can be used to support a maximum of four tuners, for example a two tuner PVR and at least one STB, comprising no more than two existing STBs.

In the system for the delivery of television content 300, the plurality of LNB outputs 290 comprises four LNB outputs. These four LNB outputs  
30 transmit four separate transport streams. Each separate transport stream is operatively associated with a tuner, thereby enabling said tuner to transmit said

transport stream for display on a display device (not shown), for example a television.

Referring back to Fig. 6, the system for the delivery of television content to many slave STBs 600 illustrates how a four output LNB can be used to support more than four tuners, for example a two tuner PVR and a plurality of existing STBs 610.

In the system for the delivery of television content to many slave STBs 600, the plurality of LNB outputs 290 comprises four LNB outputs. By way of example only, the first LNB output 293 may preferably correspond to horizontal high frequencies, the second LNB output 294 may preferably correspond to horizontal low frequencies, the third LNB output 295 may preferably correspond to vertical high frequencies, and the fourth LNB output may preferably correspond to vertical low frequencies.

The transport stream is delivered via the four LNB outputs to the PVR 140 and to the plurality of STBs 610, comprising a first STB 690 and other STBs up to an Nth set top box 699.

The PVR 140 is linked to the plurality of STBs 610 via a plurality of two way communication links 675, comprising a first communication link 680 for the first STB 690, and a separate two way communication link for each STB of the plurality of STBs 610, up to an Nth communication link 685.

Reference is now made to Fig. 7, which is a simplified partly pictorial, partly block illustration of a preferred implementation of a portion of the system of Fig. 6.

The system of Fig. 7 illustrates a system for the delivery of television content 700 via a transmission mechanism such as a satellite dish 120.

The plurality of LNB outputs 290 is delivered from the LNB 130 to the PVR 140. The PVR 140 comprises:

at least one switch 705, comprising a first switch 710, a second switch 715, a third switch 720, a fourth switch 725, a fifth switch 730, and an Nth switch 735;

at least one PVR tuner 740, comprising a first tuner 745, and a second tuner 750;

a storage device 757, which stores television content including a program 759;

a remultiplexer 760;

a modulator, for example a Quadrature Phase Shift Keying (QPSK)

5 Modulator 763;

a local oscillator 765;

a mixer 768; and

a plurality of combiners 770 comprising a first combiner 772, a second combiner 774, a third combiner 776, and an Nth combiner 778.

10 A plurality of two way communication links 780, comprising a first two way communication link 782, a second two way communication link 784, a third two way communication link 786 and an Nth two way communication link, transmit the signals outputted by the plurality of combiners 770 to the plurality of STBs 790.

15 The plurality of STBs 790 comprises a first STB 792, a second STB 794, a third STB 796, and an Nth STB 799.

A transport stream is typically carried as a single signal. Typically, there are more signals being transmitted than can fit in the cable from the satellite dish to the STB. Therefore, part of the function of the LNB is to select a subset of  
20 these signals for delivery to the STB. This subset is likely to contain more than one transport stream. From a given subset of signals, the tuner in the STB tunes to the one transport stream it needs. The tuner uses control signals to the LNB to indicate which subset of signals it needs the LNB to provide.

The LNB must output all the signals using as many wires, each  
25 carrying a subset of signals, as is required. In the example of Fig. 7, the four output LNB provides four subsets of signals. Four outputs are used by way of example only; a given satellite platform may require more than four or less than four subsets of signals. The switching architecture is believed to be valid for systems having a wide range of numbers of outputs.

30 L-band cables traditionally connect PVR and STB tuners to the LNB. The function of the LNB is to select horizontal or vertical polarization, and to down-convert the broadcast Radio frequency (RF) to an intermediate frequency

(IF) in the L-band. The L-band frequency range is 950 MHz – 2150 MHz. Since the range of frequencies used to broadcast is greater than the L-band bandwidth, two different local oscillator (LO) frequencies are used in the LNB.

The first tuner 745 and the second tuner 750 preferably control the LNB 130, typically selecting between horizontal and vertical polarization by the application of one of two DC voltage levels, and selecting between high and low LO frequencies by the presence or absence of a 22 kHz tone, as is well known in the art. Generally, when the 22 kHz tone is present, the high LO frequencies are selected.

Each switch samples the appropriate voltage range from the voltage and presence/absence of 22 kHz tone provided by the tuner it is connected to. The inputs to the switch from the LNB are permanently driven to each quadrant by hardwired application of the appropriate tone/voltage. The embodiment of Fig. 7 moves the switching function that normally occurs at the LNB into the PVR box.

Each switch 705 switches to the subset of signals that contain the desired transport stream by sampling the frequency from the appropriate quadrant, comprising vertical high, vertical low, horizontal high, or horizontal low.

Any additional amplification and / or load matching required is not shown in Fig. 7; persons skilled in the art will readily appreciate how to provide amplification/load matching

It is well understood in the art that signal attenuation occurs in wired delivery architectures. The specified signal levels for connecting a STB to a satellite dish LNB typically are designed to allow for 100 feet distance of cable. For example, typical cable used to connect the LNB to the tuner in a STB the L-band frequencies can be attenuated by 9 dB over 100 feet of cable. In the architecture proposed it is possible that the PVR device could be 100 feet distance from the LNB. Furthermore, the slave STB device could be a further 100 feet distance from the PVR device. Hence to achieve a suitable signal strength for the slave STB the broadcast signals from the LNB can be boosted (amplified) in the PVR device by 9 dB. It is understood that appropriate signal amplification can be applied to address attenuation due to the length of cable or to other sources of attenuation.



The first switch 710 switches to the subset of signals that contain the desired transport stream for the first tuner 745. The above-mentioned live transport stream can be viewed by a user (not shown) on an associated display device (not shown) or recorded onto the storage device 757.

5           The second switch 715 switches to the subset of signals that contain the desired transport stream for the second tuner 750. The above-mentioned live transport stream can be viewed by a user (not shown) on an associated display device (not shown) or recorded onto the storage device 757.

          If an STB requests content from the PVR 140, EMMs and other  
10       data 752 are sent from one of the at least one PVR tuner 740 to the remultiplexer 760. The program 759 is sent from the storage device 757 to the remultiplexer 760. The remultiplexer multiplexes the program 759 and the EMMs and other data 752 together in the form of a signal, which is then sent to the QPSK modulator 763 which remodulates the signal.

15           The local oscillator 765 produces a carrier wave, which is mixed with the output of the QPSK modulator 763 by the mixer 768 to produce a signal which is of similar form of a live broadcast signal, which the plurality of STBs 790 is therefore able to process and present in the same manner in which live broadcast signals are presented.

20           The output of the mixer 768 is combined by the first combiner 772 with the live broadcast outputted from the third switch 720 to deliver a combined signal to the first STB 782.

          The output of the mixer 768 is combined by the second combiner 774 with the live broadcast outputted from the fourth switch 725 to deliver a  
25       combined signal to the second STB 784.

          The output of the mixer 768 is combined by the third combiner 796 with the live broadcast outputted from the fifth switch 730 to deliver a combined signal to the third STB 786.

          The output of the mixer 768 is combined by the Nth combiner 788  
30       with the live broadcast outputted from the Nth switch 735 to deliver a combined signal to the Nth STB 799.

Thus, the plurality of STBs 790 have access to live content and to the content stored on the PVR 140 and have at least limited PVR functionality.

It is appreciated that, for the STB to be able to tune to the signal generated by the PVR box, there must be a previously agreed upon mechanism  
5 between the client and the server. For example, the STB may preferably need to be provided with the tuning frequency, the symbol rate and the forward error correction (FEC) rate of the desired signal. If the signal generated by the PVR box is a multi program transport stream, then the STB also needs to be provided with data which identifies which service in this transport stream is the desired  
10 service.

In one preferred embodiment, these signal parameters can be set by default in the system, in such a manner that the PVR always outputs a fixed set of parameters that are known by the application running on the client STB. Alternative approaches also exist, for example the PVR can communicate these  
15 parameters to the client STB using an out of band communications path when the STB makes a request for content to be played.

Reference is now made to Fig. 8, which is a simplified partly pictorial, partly block illustration of an alternative preferred implementation of a portion of the system of Fig. 6.

20 The system of Fig. 8 illustrates an alternate system for the delivery of television content 800 via a transmission mechanism such as a satellite dish 120.

The system of Fig. 8 is similar to the system of Fig. 7 except as described below.

25 In Fig. 8, the live broadcast and the remodulated remixed television program are not combined together with combiners. In place of the plurality of combiners 770 in Fig. 7, there are provided at least one selection switch 810, comprising an Ath Switch 815, a Bth Switch 820, a Cth Switch 825, and a Pth switch 830.

30 When a user (not shown) instructs the control mechanism (not shown) to select live content, the corresponding one of the at least one selection switch 810 selects the live output from the corresponding switch.

The at least one switch 705 comprises a plurality of four input switches that reconfigure the transport stream from the four frequency ranges that the transport stream has been represented on.

5 The at least one selection switch 810 comprises a plurality of two input switches that selects live content or the remultiplexed remodulated signal which is output by the mixer and comprises content stored on the storage device 757.

10 When a viewer (not shown) associated with the first STB 792 chooses to select live content, the Ath Switch 815 selects the output of the third Switch 720, which comprises the live transport stream.

When the viewer (not shown) associated with the first STB 792 selects the program 759 which is stored on the storage device 757, the Ath Switch 815 selects the output of the mixer 768, which comprises the remodulated remultiplexed signal which the first STB 792 can process the same way live  
15 transport streams are processed.

When a viewer (not shown) associated with the second STB 794 chooses to select live content, the Bth Switch 820 selects the output of the fourth Switch 725, which comprises the live transport stream.

20 When the viewer (not shown) who is viewing content on the display device (not shown) associated with the second STB 794 selects the program 759 which is stored on the storage device 757, the Bth Switch 820 selects the output of the mixer 768, which comprises the remodulated remultiplexed signal which the second STB 794 can process the same way live transport streams are processed.

25 When a viewer (not shown) associated with the third STB 796 chooses to select live content, the Cth Switch 825 selects the output of the fifth Switch 730, which comprises the live transport stream.

30 When the viewer (not shown) who is viewing content on a display device (not shown) associated with the third STB 796 selects the program 759 which is stored on the storage device 757, the Cth Switch 825 selects the output of the mixer 768, which comprises the remodulated remultiplexed signal which the third STB 796 can process the same way live transport streams are processed.

When a viewer (not shown) associated with the Nth STB 799 chooses to select live content, the Pth Switch 830 selects the output of the Nth Switch 735, which comprises the live transport stream.

5 When the viewer (not shown) who is viewing content on the display device (not shown) associated with the Nth STB 799 selects the program 759 which is stored on the storage device 757, the Pth Switch 830 selects the output of the mixer 768, which comprises the remodulated remultiplexed signal which the Nth STB 799 can process the same way live transport streams are processed.

10 Reference is now made to Fig. 9, which is a simplified partly pictorial, partly block illustration of another preferred implementation of a portion of the system of Fig. 6.

The system of Fig. 9 illustrates another system for the delivery of television content 900 via a transmission mechanism such as a satellite dish 120.

15 The system of Fig. 9 is similar to the system of Fig. 8 except as described below.

Referring back to Fig. 8, there are two sets of switches, the at least one switch 705, which reconfigures the live transport stream from four frequency ranges, and the at least one selection switch 810, which selects live content or stored content for display on a display device (not shown).

20 Referring back to Fig. 9, at least one master switch 905 comprise a first master switch 920, a second master switch 925, a third master switch 930, and an Nth master switch 935.

25 A plurality of switches 907 comprises a first switch 910 and a second switch 915. The first switch 910 corresponds to the first switch 710 in Fig. 7. The second switch 915 corresponds to the second switch 715 in Fig. 7.

The at least one master switch 905 switches to the subset of signals that contain the desired transport stream as well as selects live content or stored content for display on a display device (not shown).

30 A control mechanism (not shown) sends control messages to the at least one master switch 905, control messages instruct the plurality of master switches to select live content or stored content for display.

When the first master switch 920 is instructed to select stored content, the first master switch 920 selects the signal that is outputted by the mixer 768. The signal outputted by the mixer 768 is then outputted by the first master switch 920 to the first two way communication link 782. The signal outputted by  
5 the mixer 768 is then processed by the first STB 792 in the same way a live signal would be processed (or in so close a way as to be equivalent thereto) and then displayed on an associated display device (not shown).

When the first master switch 920 is instructed to select live content, the first master switch 920 then switches to the subset of signals that contain the  
10 desired transport stream in the same manner that the third switch 720 switches to the subset of signals that contain the desired transport stream in Fig. 7.

When the second master switch 925 is instructed to select stored content, the second master switch 925 selects the signal that is outputted by the mixer 768. The signal outputted by the mixer 768 is then outputted by the second  
15 master switch 925 to the second two way communication link 784. The signal outputted by the mixer 768 is then processed by the second STB 794 in the same way a live signal would be processed (or in so close a way as to be equivalent thereto) and then displayed on an associated display device (not shown).

When the second master switch 925 is instructed to select live  
20 content, the second master switch 925 then switches to the subset of signals that contain the desired transport stream in the same manner that the fourth switch 725 switches to the subset of signals that contain the desired transport stream in Fig. 7.

When the third master switch 930 is instructed to select stored content, the third master switch 930 preferably selects the signal that is outputted  
25 by the mixer 768. The signal outputted by the mixer 768 is then preferably outputted by the third master switch 930 to the third two way communication link 786. The signal outputted by the mixer 768 is then processed by the third STB 796 in the same way a live signal would be processed (or in so close a way as to be equivalent thereto) and then displayed on an associated display device (not  
30 shown).

When the third master switch 930 is instructed to select live content, the third master switch 930 then switches to the subset of signals that

contain the desired transport stream in the same manner that the fifth switch 730 switches to the subset of signals that contain the desired transport stream in Fig. 7.

When the Nth master switch 935 is instructed to select stored  
5 content, the Nth master switch 935 selects the signal that is outputted by the mixer 768. The signal outputted by the mixer 768 is then outputted by the second master switch 935 to the fourth two way communication link 788. The signal outputted by the mixer 768 is then processed by the Nth STB 799 in the same way a live signal would be processed (or in so close a way as to be equivalent thereto) and  
10 then displayed on an associated display device (not shown).

When the Nth master switch 935 is instructed to select live content, the second master switch 935 switches to the subset of signals that contain the desired transport stream the live transport stream in the same manner (or so close in form as to be equivalent thereto) that the nth switch 735 switches to the subset  
15 of signals that contain the desired transport stream in Fig. 7.

Reference is now made to Fig. 10, which is a simplified flowchart illustration of a preferred method of operation of the system of Fig. 2. The method of Fig. 10 is self-explanatory with reference to the above description.

Reference is now made to Fig. 11, which is a simplified flowchart  
20 illustration of a preferred method of operation of the system of Fig. 2. The method of Fig. 11 is self-explanatory with reference to the above description.

Reference is now made to Fig. 12, which is a simplified graphical illustration of variable bitrate with respect to time.

When a PVR device records an event the video and audio transport  
25 stream (TS) packets are demultiplexed from the broadcast transport stream and stored in scrambled form. If the broadcast event was encoded using variable bitrate then the stored content will also be characterized by variable bitrate, as illustrated by Fig. 12. When stored content is played on a PVR device the MPEG-2 decoder works in a "pull" mode because stored content is being "pulled".  
30 from the disk. Content is pulled into the decoder via a suitable buffer at a rate determined by the decoder itself.

In one PVR architecture the PVR device serves stored content to separate client DVB-S compliant set top boxes as shown in Figure 4. The DVB-S set top box consumes the content via its standard tuner input, constraining the input to be a DVB-S modulated full rate MPEG-2 transport stream. The set top  
5 box is unaware that the PVR content does not originate from a broadcaster but from the PVR device.

The PVR device hence needs to push the content to the client in an MPEG-2 compliant manner. Pushing content to the client will involve the creation of suitable system information (SI), but the stored content must be  
10 remultiplexed into a full rate transport stream. Pushing content to the client must be performed such that the standard MPEG-2 buffers are not violated by buffer overflow or buffer underflow. The content must be remultiplexed into a full rate transport stream at the appropriate rate, a rate that can vary as seen in Fig. 12.

A full rate transport stream is equivalent to that which is transmitted  
15 on a single satellite transponder. Content must be remultiplexed into a full rate transport stream because the client STB is not designed to be able to tune and demodulate any other signal.

Reference is now made to Fig. 13, which is a simplified graphical illustration of variable video bitrate with respect to program clock reference.

20 Fig. 13 illustrates PCR instances relative to an example variable bitrate stream.

For an MPEG-2 transport stream to be compliant a program clock reference (PCR) value must be carried every 100 ms (subclause 2.7.3 of ISO/IEC 13818-1). DVB implementation guidelines (subclause 4.1.5.3 of ETSI TR 101 154 V1.4.1)  
25 recommend that a PCR value is carried every 40 ms. Fig. 13 shows the PCR instances for an example variable bitstream.

The instantaneous bitrate of a stored variable bitrate stream is unknown and therefore the instantaneous rate at which to remultiplex the data to guarantee MPEG-2 compliance is also unknown. However, if the transport  
30 packets that contain the PCR for the recorded service are stored with the content then it is possible to calculate the average bitrate between the PCR instances. It is

then possible to remultiplex the stored stream in a piecewise linear fashion, i.e.: at a constant bitrate between the PCR instances.

Reference is now made to Fig. 14, which is a simplified graphical illustration of a piecewise linear approximation to the variable video bitrate of Fig. 13. Fig. 14 illustrates the piecewise linear remultiplexing for the variable bitrate example of Fig. 13.

To be able to apply the piecewise linear remultiplexing the PCR TS packets values are preferably logically stored interleaved with the content TS packets in the order that they were transmitted.

The PCR values are preferably carried in the adaptation layer of MPEG-2 transport packets as specified in ISO/IEC 13818-1. The process to identify transport packets comprising PCR values and to read the value is preferably as follows:

Is the adaptation\_field\_control in the transport packet header set to 2 or 3?

If the adaptation\_field\_control is set to any value other than 2 or 3, then the transport packet being tested is not the PCR. If the adaptation\_field\_control is two or three, the adaptation\_field\_length is tested.

Is the adaptation\_field\_length > 0?

If the adaptation\_field\_length is not greater than zero, then the transport packet being tested is not the PCR. If the adaptation\_field\_length > 0, then the PCR\_flag is checked.

Is the PCR\_flag set?

If the PCR\_flag is not set, then the transport packet being tested is not the PCR. If the PCR\_flag is set, the packet being examined is the PCR.

The PCR value is read.

Further details of the MPEG-2 transport stream are well known in the art and are specified in ISO/IEC 13818-1.

To calculate the piecewise linear insertion rate two consecutive PCR values are read and the number of content packets between PCR instances counted. The difference between the two consecutive PCR values can be calculated and will be in terms of 27 MHz clock cycles. In other words, the PCR



clock rate is 27,000,000. The packet size is the size of the packets in bits; in the case of an MPEG-2 transport stream, for example, packet size may be either 188 bytes (188 \* 8 bits) or 204 bytes (204 \* 8 bits).

5 The potential for the PCR wrap round should be considered when calculating the PCR difference.

From the time interval calculated between PCR values, termed herein "PCRdifference", and the number of transport packets (including only one of the PCR packets) to insert in that period, termed herein "packetcount", it is possible to calculate the piecewise linear bitrate for the content for the period  
10 between the read PCRs:

$$\text{bitrate} = \frac{\text{packetcount} * \text{packetsize} * 27000000}{\text{PCRdifference}}$$

In ISO/IEC 13818-1 PCR tolerance is defined as the maximum  
15 inaccuracy allowed in received PCRs. This inaccuracy may be due to imprecision in the PCR values or to PCR modification during remultiplexing. The PCR tolerance is  $\pm 500$  ns.

An alternative approach avoids the requirement to extract the PCR values from the TS packets. During the recording of the content the arrival time  
20 of each PCR packet is logged with respect to an accurate local clock. To calculate the piecewise linear bitrate for the content for the period between the read PCRs it is possible to substitute the local clock difference and local clock rate for the *PCRdifference* and 27,000,000 values in the equation above.

In PVRs the stored PCR packets may be delivered in a full rate  
25 MPEG-2 TS multiplex. If the PCR packets are re-inserted with packet accuracy into an MPEG-2 TS of the same full rate then the PCR tolerance will be met.

For cases where the rate of the output TS multiplex differs from the rate at which the PCRs were originally recorded, PCR jitter can be introduced. If the recorded PCR packet is simply reinserted in the closest applicable output TS  
30 packet then the maximum PCR jitter that occurs is:

$$PCRJitter = \frac{packetsize}{OutputTSrate \times 2}$$

Calculating the PCR jitter for the 204 byte TS packets output in a multiplex of 36,666,666 bits/sec:

$$5 \quad PCRJitter = \frac{204 \times 8}{36,666,666 \times 2} = 22.2 \times 10^{-6} \text{ sec}$$

It is appreciated that  $22.2 \times 10^{-6}$  is approximately 44 times the MPEG defined PCR tolerance. The behavior of the client STB in the presence of this PCR jitter is undefined. However, all practical tests so far have shown the client STB to be unaffected by such PCR jitter. Where the jitter is an issue for the client devices the PCR timestamps can be corrected as part of the transmission process.

When inserting a PCR packet in the transport stream, given the value of the last PCR value output, the bitrate of the output transport stream, and the number of packets output since the last PCR was output, it is possible to calculate the correct value for the PCR value about to be output. Thus, if required, the transmission process could preferably restamp the PCR value with the calculated PCR value

Reference is now made to Fig. 15, which is a simplified flowchart illustration of a preferred method of operation of a method of producing a full rate output transport stream. Fig. 15 is self-explanatory except as described below.

In the method of Fig. 15, P and Q are integers. Bitrate is the bitrate calculated above. TSbitrate is the full rate output transport stream bitrate.

At the start of the method of Fig. 15, it is assumed that the last packet transport packet output contained a PCR. Hence the constant bitrate for the next set of packets to be inserted has been calculated as described above. Fig. 15 shows a decision being made on a packet by packet basis as to whether to output a content packet or a NULL packet. In this instance the output of a NULL packet indicates the output of any packet that is not part of the stored content, and could include SI information or other data. The process described in Fig. 15 can be

modified for the case of simultaneously outputting multiple pieces of stored content as is well known in the art.

It is appreciated that various features of the invention which are, for clarity, described in the contexts of separate embodiments may also be provided in  
5 combination in a single embodiment. Conversely, various features of the invention which are, for brevity, described in the context of a single embodiment may also be provided separately or in any suitable subcombination.

It will be appreciated by persons skilled in the art that the present invention is not limited by what has been particularly shown and described  
10 hereinabove. Rather the scope of the invention is defined only by the claims which follow:

What is claimed is:

# CLAIMS

1. An audio visual content server comprising:  
5 a content storage unit operative to store audio and / or video content;  
a content transmission unit comprising a modulator and operative to receive digital signals comprising encoded audio and / or video content and to transmit modulated signals to at least one receiving device; and  
10 a tuner unit operative to:  
receive input signals comprising encoded audio and / or video content; and  
output the received signals to the content storage unit for storage therein,  
15 wherein the content transmission unit receives said signals at least from the content storage unit.
2. The audio visual content server according to claim 1 and wherein the content transmission unit also includes a remultiplexer, and the content  
20 transmission unit is operative to transmit remultiplexed modulated signals.
3. The audio visual content server according to claim 2 and wherein the remultiplexer comprises a piecewise linear remultiplexer.
- 25 4. The audio visual content server according to any of claims 1 - 3 and wherein the modulator comprises a QPSK modulator.
5. The audio visual content server according to any of claims 1 - 3 and wherein the modulator comprises a QAM modulator.
- 30 6. The audio visual content server according to any of claims 1 - 3 and wherein the modulator comprises a OFDM modulator.

7. The audio visual content server according to any of claims 1- 3 and wherein the modulator comprises a 8VSB modulator.
- 5 8. The audio visual content server according to any of claims 1 - 7 and wherein the at least one receiving device comprises a plurality of receiving devices.
9. The audio visual content server according to claim 8 and wherein  
10 the content transmission unit further comprises a switching unit operative to output the signals to one or more of the plurality of receiving devices.
10. The audio visual content server according to claim 8 and wherein  
15 the switching unit receives a control input and the switching unit outputs the signals to one or more of the plurality of receiving devices based, at least in part, on the control input.
11. The audio visual system according to any of the above claims and  
20 wherein the content transmission unit also receives said signals from an external source.
12. The audio visual system according to any of claims 1 - 10 and wherein the content transmission unit receives said signals only from the content  
25 storage unit.
13. The audio visual content server according to any of the above claims and wherein the tuner unit comprises a plurality of tuners operative to:  
receive input signals comprising encoded audio and / or video  
30 content and to output the received signals to the content storage unit for storage therein.

14. The audio visual content server according to any of the above claims and wherein the input signals comprise control data.
15. The audio visual content server according to claim 14 and wherein  
5 at least a portion of the control data is delivered to the receiving device.
16. The audio visual content server according to claim 14 or claim 15 and wherein the control data comprises at least one of the following:  
at least one EMM; and  
10 system information.
17. The audio visual content server according to any of claims 14 - 16 and wherein the control data is delivered in band.
- 15 18. The audio visual content server according to any of claims 14 - 16 and wherein the control data is delivered out of band.
19. The audio visual content server according to any of the above claims and wherein the receiving device comprises a set top box.  
20
20. The audio visual content server according to claim 19 and wherein the receiving device comprises a DVB-S compliant set top box.
21. The audio visual content server according to claim 20 and wherein  
25 the audio visual content server has remultiplexing and / or modulation parameters which are DVB-S compliant.
22. The audio visual content server according to claim 20 and wherein the audio visual content server has remultiplexing and / or modulation parameters  
30 which are not DVB-S compliant.

23. The audio visual content server according to claim 19 and wherein the receiving device comprises a DVB-C compliant set top box.

24. The audio visual content server according to claim 23 and wherein  
5 the audio visual content server has remultiplexing and / or modulation parameters which are DVB-C compliant.

25. The audio visual content server according to claim 23 and wherein the audio visual content server has remultiplexing and / or modulation parameters  
10 which are not DVB-C compliant.

26. The audio visual content server according to claim 19 and wherein the receiving device comprises a DVB-T compliant set top box.

15 27. The audio visual content server according to claim 26 and wherein the audio visual content server has remultiplexing and / or modulation parameters which are DVB-T compliant.

28. The audio visual content server according to claim 26 and wherein  
20 the audio visual content server has remultiplexing and / or modulation parameters which are not DVB-T compliant.

29. The audio visual content server according to claim 19 and wherein the receiving device comprises a ATSC compliant set top box.

25 30. The audio visual content server according to claim 29 and wherein the audio visual content server has remultiplexing and / or modulation parameters which are ATSC compliant.

30 31. The audio visual content server according to claim 29 and wherein the audio visual content server has remultiplexing and / or modulation parameters which are not ATSC compliant.

32. The audio visual content server according to claim 19 and wherein the receiving device comprises a DSS compliant set top box.
- 5 33. The audio visual content server according to claim 32 and wherein the audio visual content server has remultiplexing and / or modulation parameters which are DSS compliant.
34. The audio visual content server according to claim 32 and wherein  
10 the audio visual content server has remultiplexing and / or modulation parameters which are not DSS compliant.
35. The audio visual content server according to claim 19 and wherein the receiving device comprises an ARIB compliant set top box.  
15
36. The audio visual content server according to claim 35 and wherein the audio visual content server has remultiplexing and / or modulation parameters which are ARIB compliant.
- 20 37. The audio visual content server according to claim 35 and wherein the audio visual content server has remultiplexing and / or modulation parameters which are not ARIB compliant.
38. The audio visual content server according to any of the above  
25 claims and wherein the receiving device comprises a television.
39. The audio visual content server according to any of the above claims and wherein the receiving device comprises a personal computer.
- 30 40. The audio visual content server according to any of the above claims and wherein the first tuner receives input signals from a broadcast source.



41. The audio visual content server according to claim 40 and wherein the broadcast source comprises a cable broadcast network.

42. The audio visual content server according to claim 40 and wherein  
5 the broadcast source comprises a satellite broadcast network.

43. The audio visual content server according to claim 40 and wherein the broadcast source comprises a terrestrial broadcast network.

10 44. The audio visual content server according to any of claims 40 - 43 and wherein the broadcast network comprises a digital broadcast network.

45. The audio visual content server according to any of claims 40 - 44 and wherein the broadcast network comprises a television network.

15

46. The audio visual content server according to claim 45 and wherein the broadcast network comprises a pay television network.

47. The audio visual content server according to any of the above  
20 claims and also comprising:

a low noise block (LNB) receiving satellite signals and providing the satellite signals to the first tuner.

48. An audio visual content server comprising:  
25 a content storage unit operative to store audio and / or video content;

a content transmission unit operative to receive signals comprising encoded audio and / or video content and to transmit the signals to at least one receiving device; and

30

a tuner unit operative to:  
receive input signals comprising encoded audio and /  
or video content; and

output the received signals to the content storage unit  
for storage therein,

wherein the content transmission unit receives said signals at least  
from the content storage unit, and

5           the input signals comprise control data, and  
          at least a portion of the control data is delivered to the receiving  
device.

49.           The audio visual system according to claim 48 and wherein the  
10   content transmission unit also receives said signals from an external source.

50.           The audio visual system according to claim 48 and wherein the  
content transmission unit receives said signals only from the content storage unit.

15   51.           The audio visual content server according to any of claims 48 - 50  
and wherein the tuner unit comprises a plurality of tuners operative to:  
          receive input signals comprising encoded audio and / or video  
content and to output the received signals to the content storage unit for storage  
therein.

20           52.           The audio visual content server according to any of claims 48 - 51  
and wherein the control data comprises at least one of the following:  
          at least one EMM; and  
          system information.

25           53.           The audio visual content server according to any of claims 48 - 52  
and wherein the control data is delivered in band.

54.           The audio visual content server according to any of claims 48 - 52  
30   and wherein the control data is delivered out of band.

55. The audio visual content server according to any of the claims 48 -  
54 wherein the content transmission unit comprises:

a remultiplexer; and  
a modulator.

5

56. The audio visual content server according to claim 55 and wherein  
the modulator comprises a QPSK modulator.

57. The audio visual content server according to claim 55 and wherein  
10 the modulator comprises a QAM modulator.

58. The audio visual content server according to claim 55 and wherein  
the modulator comprises a OFDM modulator.

15 59. The audio visual content server according to claim 55 and wherein  
the modulator comprises a 8VSB modulator.

60. The audio visual content server according to any of claims 55 - 59  
and wherein the at least one receiving device comprises a plurality of receiving  
20 devices.

61. The audio visual content server according to claim 60 and wherein  
the content transmission unit further comprises a switching unit operative to  
output the signals to one or more of the plurality of receiving devices.

25

62. The audio visual content server according to claim 60 and wherein  
the switching unit receives a control input and the switching unit outputs the  
signals to one or more of the plurality of receiving devices based, at least in part,  
on the control input.

30

63. The audio visual content server according to any of claims 48 - 62  
and wherein the receiving device comprises a set top box.

64. The audio visual content server according to claim 63 and wherein the receiving device comprises a DVB-S compliant set top box.

5 65. The audio visual content server according to claim 64 and wherein the audio visual content server has remultiplexing and / or modulation parameters which are DVB-S compliant.

66. The audio visual content server according to claim 64 and wherein  
10 the audio visual content server has remultiplexing and / or modulation parameters which are not DVB-S compliant.

67. The audio visual content server according to claim 63 and wherein the receiving device comprises a DVB-C compliant set top box.

15

68. The audio visual content server according to claim 67 and wherein the audio visual content server has remultiplexing and / or modulation parameters which are DVB-C compliant.

20 69. The audio visual content server according to claim 67 and wherein the audio visual content server has remultiplexing and / or modulation parameters which are not DVB-C compliant.

70. The audio visual content server according to claim 63 and wherein  
25 the receiving device comprises a DVB-T compliant set top box.

71. The audio visual content server according to claim 70 and wherein the audio visual content server has remultiplexing and / or modulation parameters which are DVB-T compliant.

30

72. The audio visual content server according to claim 70 and wherein the audio visual content server has remultiplexing and / or modulation parameters which are not DVB-T compliant.

5 73. The audio visual content server according to claim 63 and wherein the receiving device comprises a ATSC compliant set top box.

74. The audio visual content server according to claim 73 and wherein the audio visual content server has remultiplexing and / or modulation parameters  
10 which are ATSC compliant.

75. The audio visual content server according to claim 73 and wherein the audio visual content server has remultiplexing and / or modulation parameters which are not ATSC compliant.

15

76. The audio visual content server according to claim 63 and wherein the receiving device comprises a DSS compliant set top box.

77. The audio visual content server according to claim 76 and wherein  
20 the audio visual content server has remultiplexing and / or modulation parameters which are DSS compliant.

78. The audio visual content server according to claim 76 and wherein the audio visual content server has remultiplexing and / or modulation parameters  
25 which are not DSS compliant.

79. The audio visual content server according to claim 63 and wherein the receiving device comprises an ARIB compliant set top box.

30 80. The audio visual content server according to claim 79 and wherein the audio visual content server has remultiplexing and / or modulation parameters which are ARIB compliant.

81. The audio visual content server according to claim 79 and wherein the audio visual content server has remultiplexing and / or modulation parameters which are not ARIB compliant.

5

82. The audio visual content server according to any of claims 48 - 81 and wherein the receiving device comprises a television.

83. The audio visual content server according to any of claims 48 - 82  
10 and wherein the receiving device comprises a personal computer.

84. The audio visual content server according to any of claims 48 - 83 and wherein the first tuner receives input signals from a broadcast source.

15 85. The audio visual content server according to claim 84 and wherein the broadcast source comprises a cable broadcast network.

86. The audio visual content server according to claim 84 and wherein the broadcast source comprises a satellite broadcast network.

20

87. The audio visual content server according to claim 84 and wherein the broadcast source comprises a terrestrial broadcast network.

88. The audio visual content server according to any of claims 84 - 87  
25 and wherein the broadcast network comprises a digital broadcast network.

89. The audio visual content server according to any of claims 84 - 88 and wherein the broadcast network comprises a television network.

30 90. The audio visual content server according to claim 89 and wherein the broadcast network comprises a pay television network.

91. The audio visual content server according to any of claims 48 - 90  
and also comprising:

a low noise block (LNB) receiving satellite signals and providing  
the satellite signals to the first tuner.

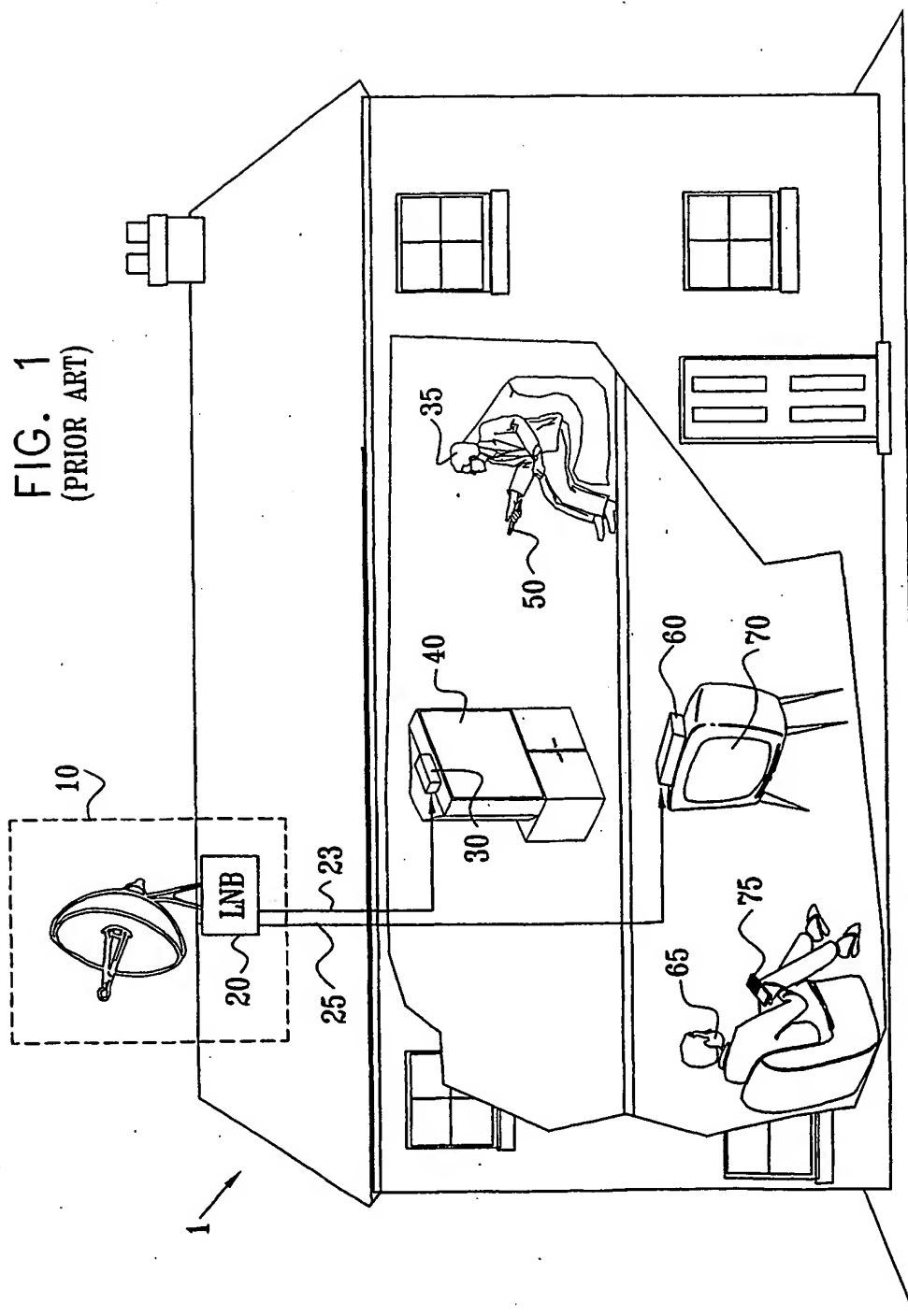
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92. A server-based audio-visual system comprising:  
the audio visual content server according to any of the above  
claims; and

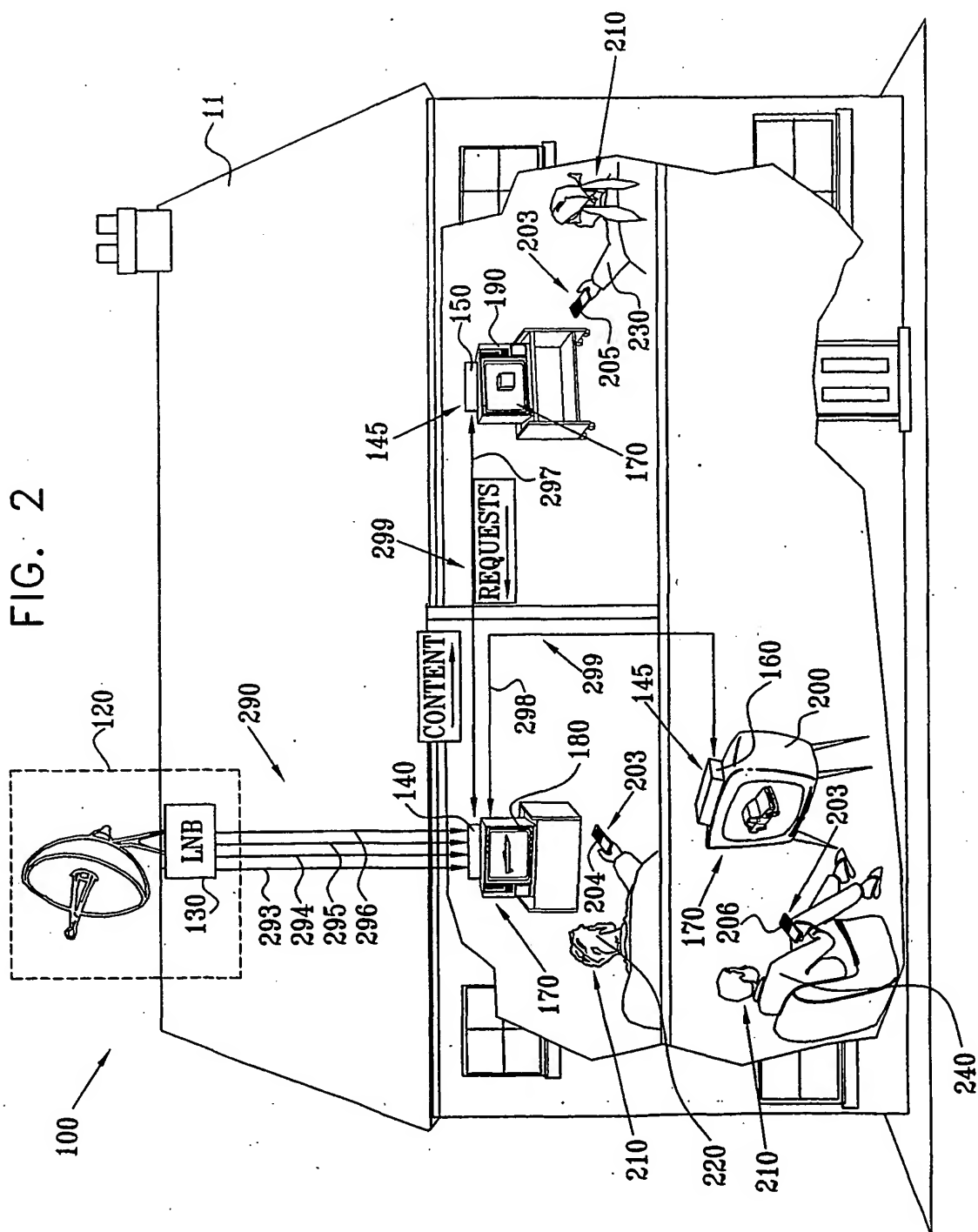
a plurality of receiving devices each receiving input from the audio  
10 visual content server.

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FIG. 1  
(PRIOR ART)

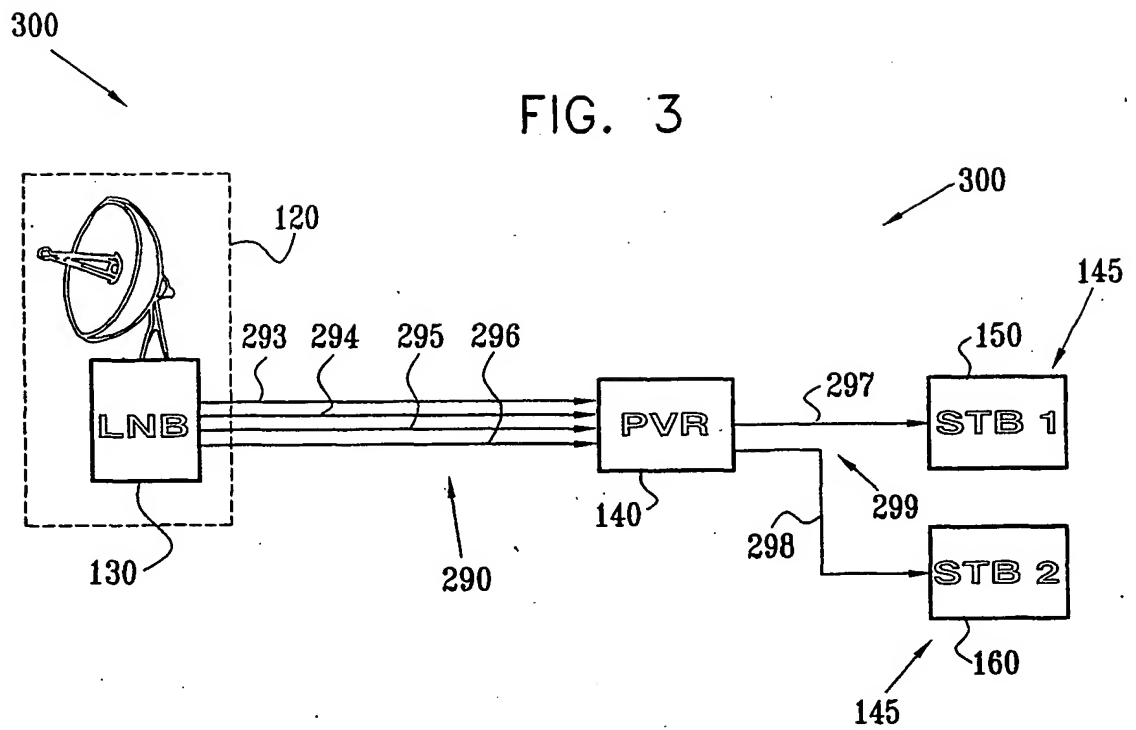






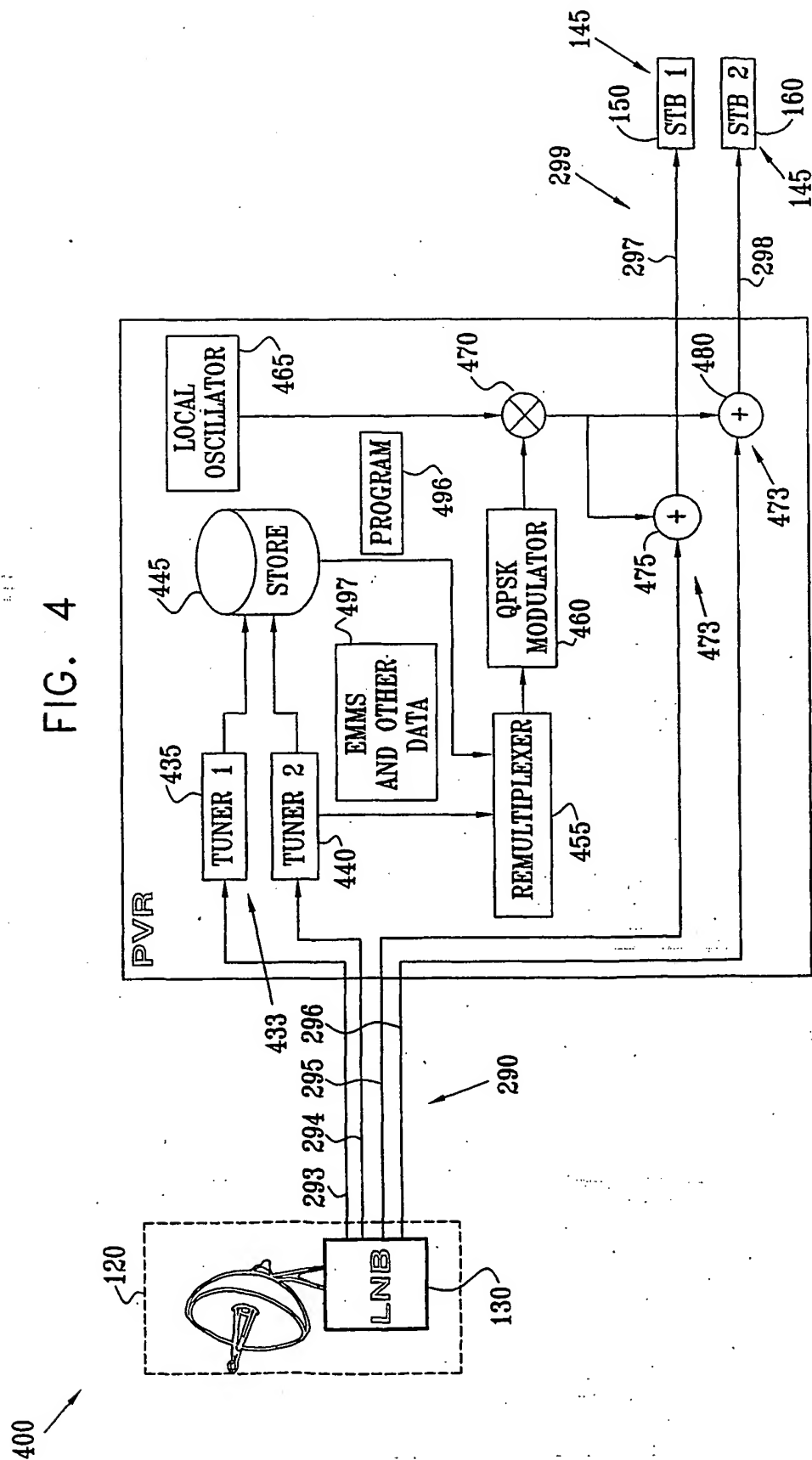
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FIG. 3



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FIG. 4



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FIG. 5

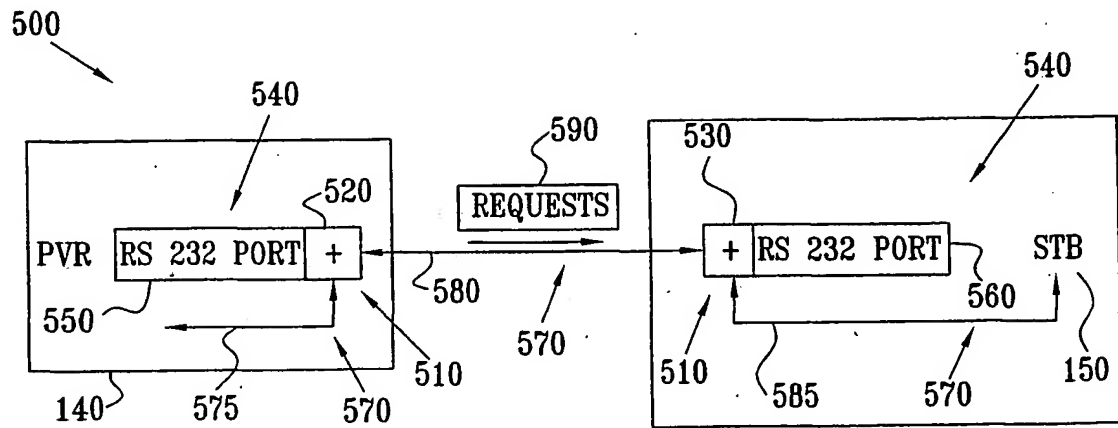
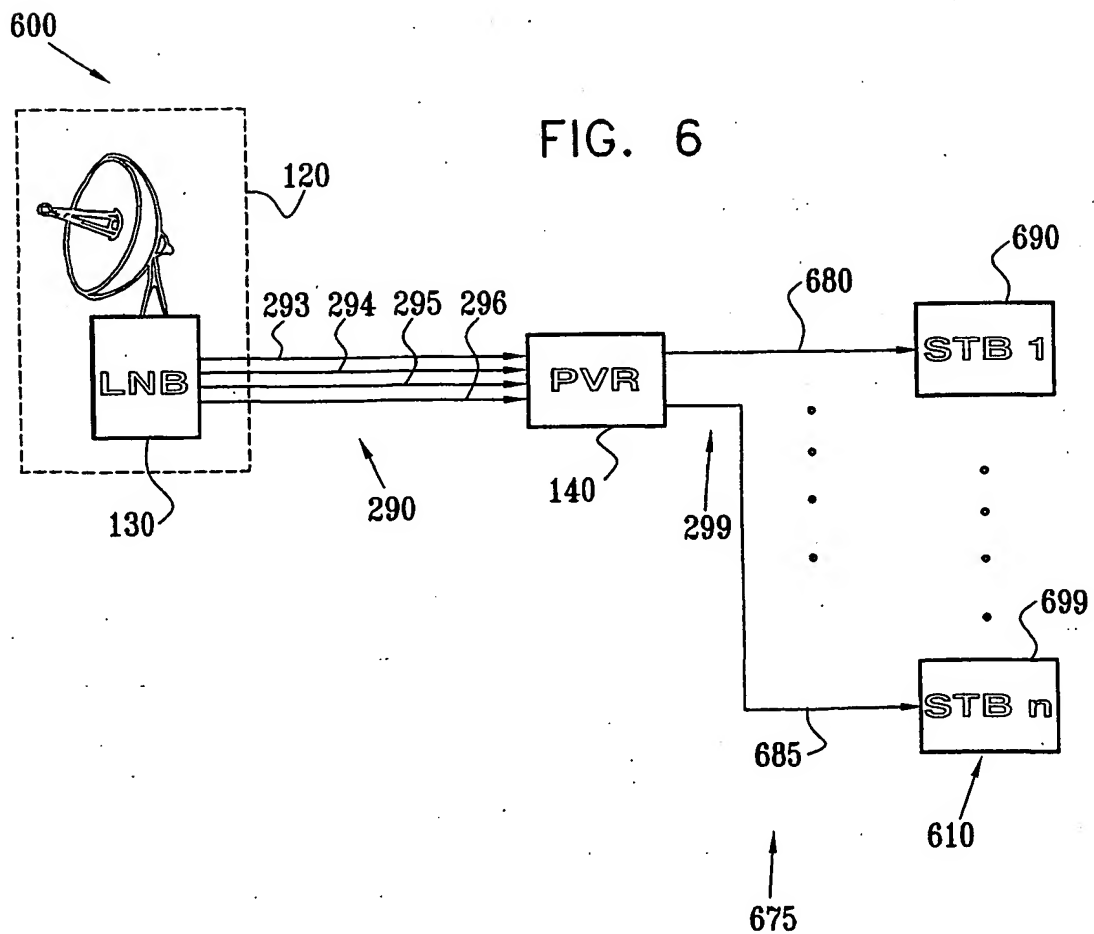


FIG. 6



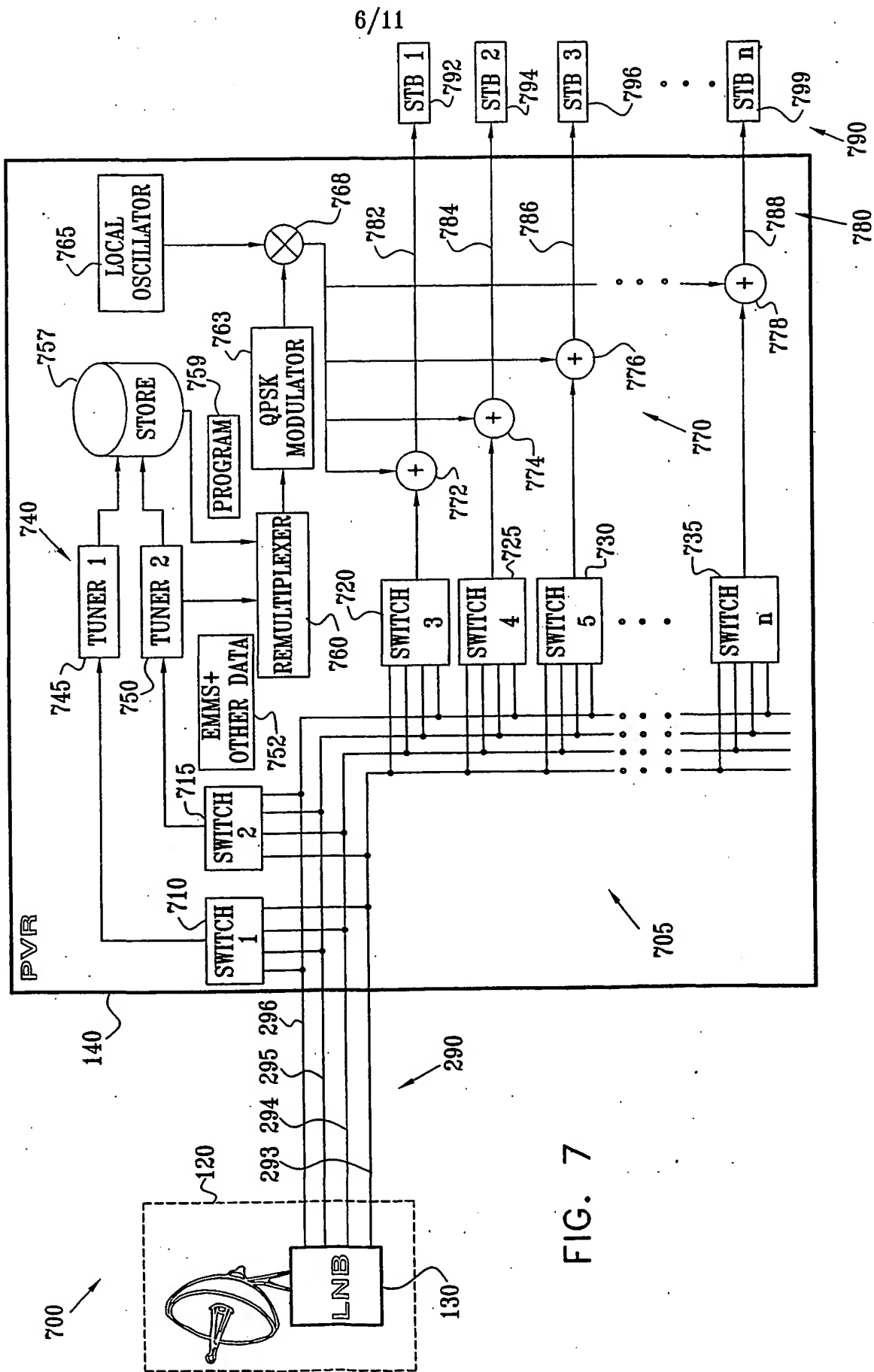


FIG. 7

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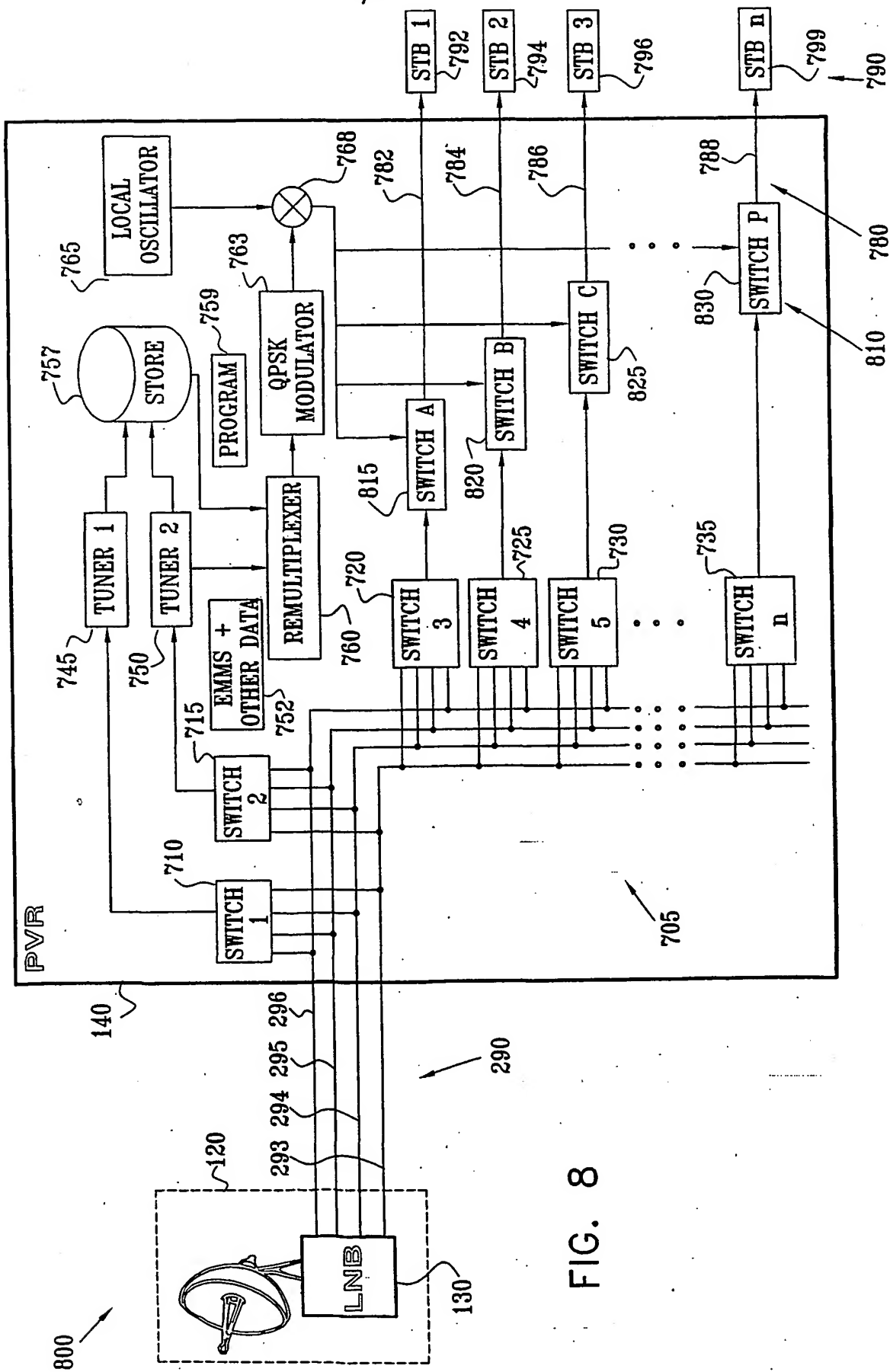


FIG. 8

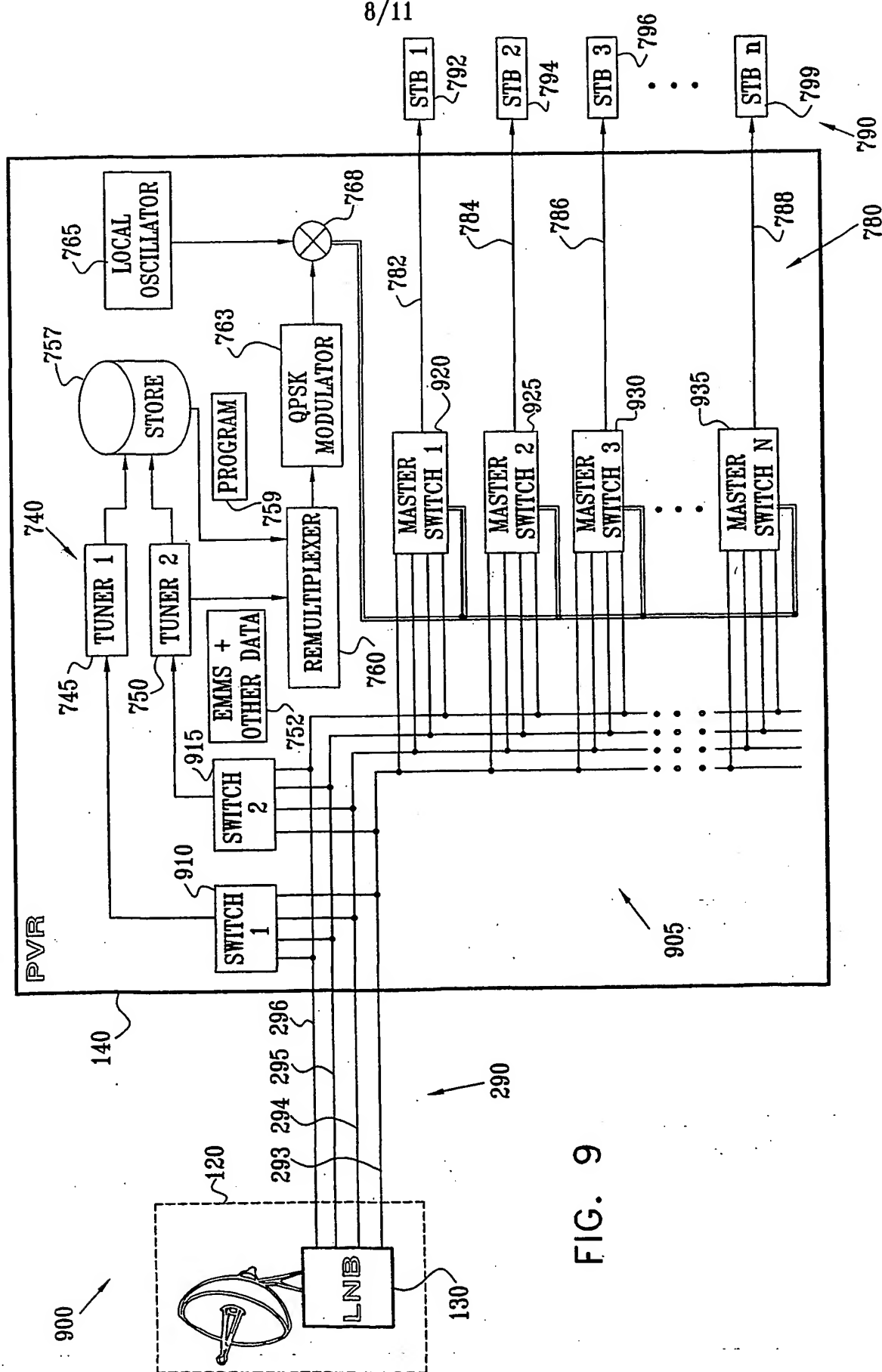


Fig. 6

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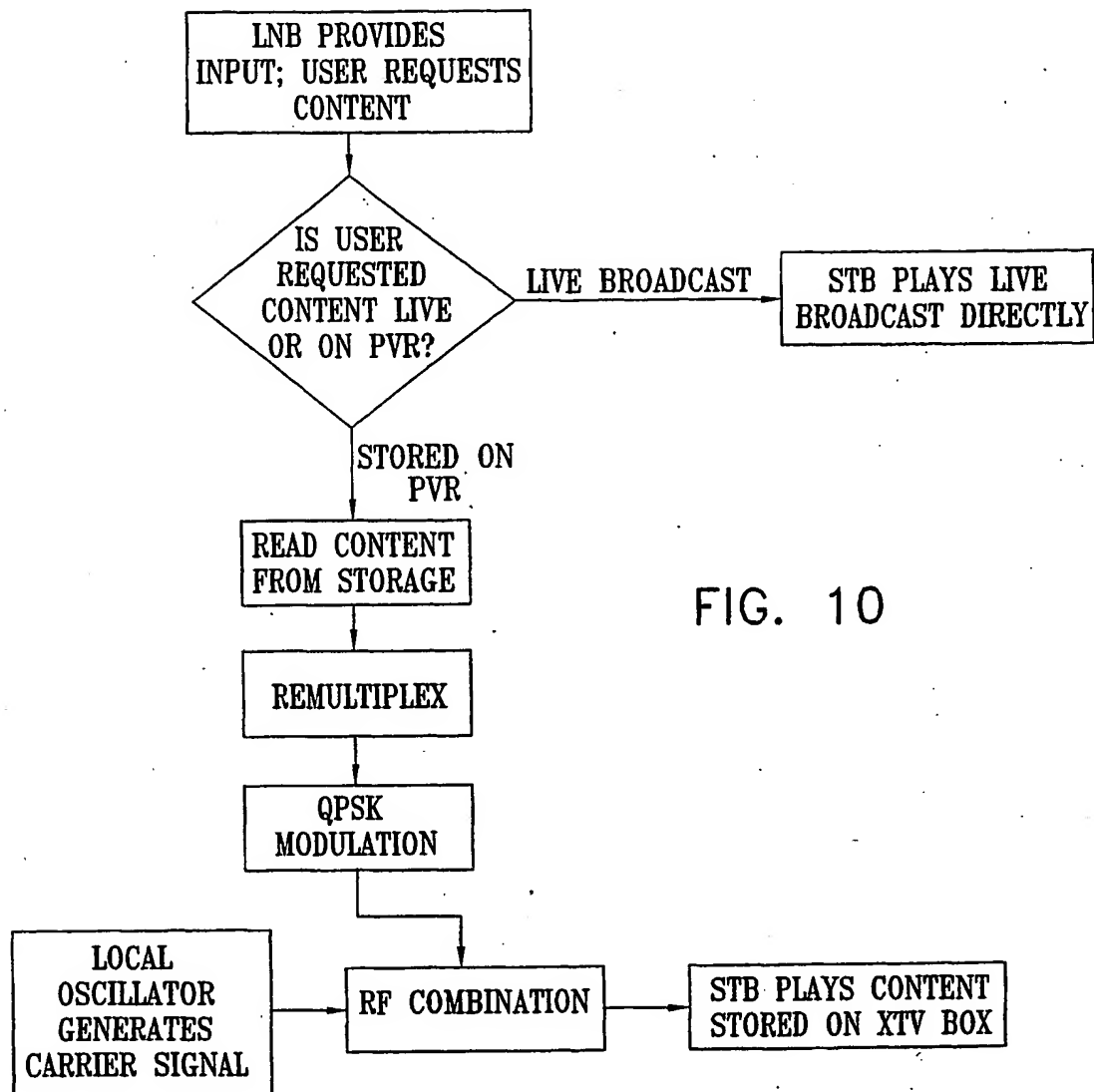
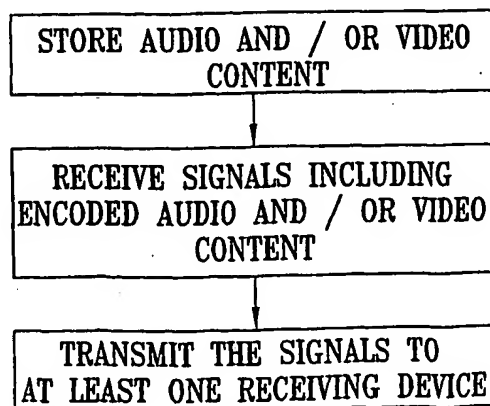


FIG. 11





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FIG. 12

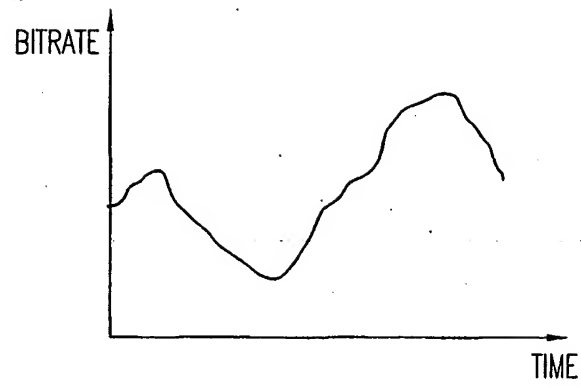


FIG. 13

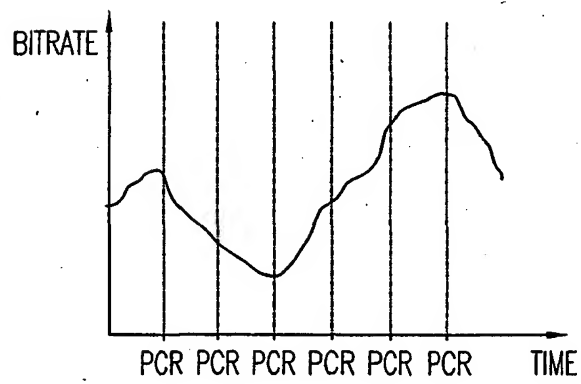
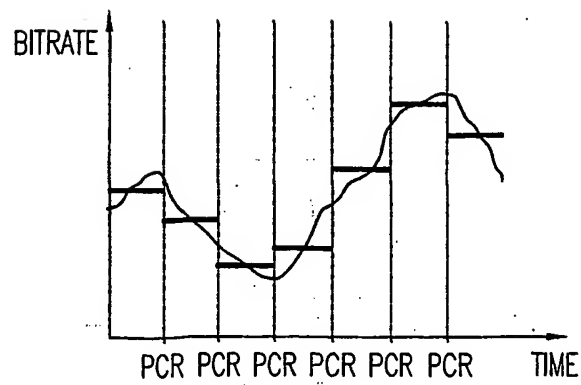
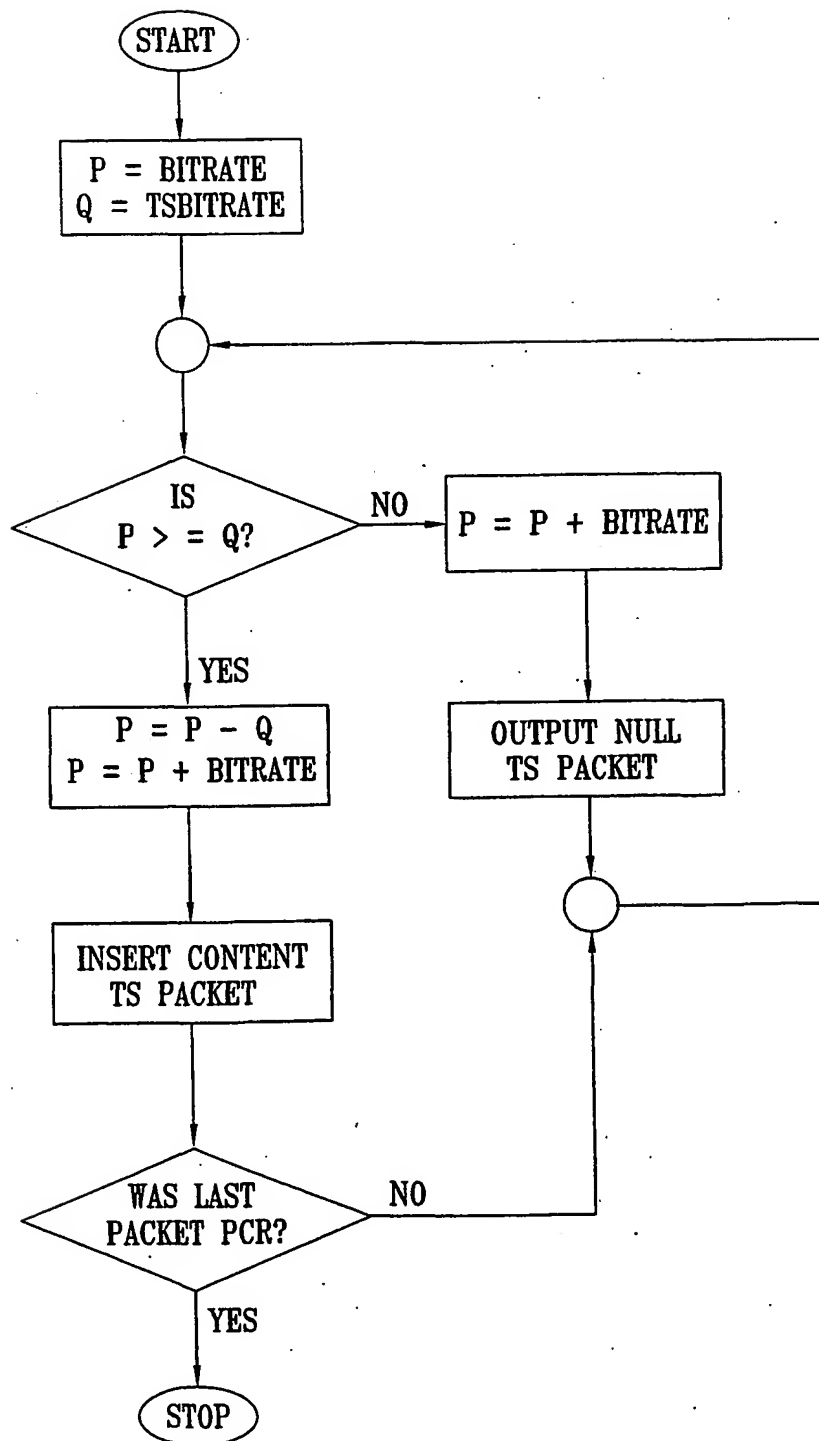


FIG. 14



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FIG. 15



(19) World Intellectual Property Organization  
International Bureau



(43) International Publication Date  
7 November 2002 (07.11.2002)

PCT

(10) International Publication Number  
**WO 02/089479 A3**

(51) International Patent Classification<sup>7</sup>: H04N 7/10, 7/173

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(21) International Application Number: PCT/IB02/01359

(22) International Filing Date: 17 April 2002 (17.04.2002)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:  
0110272.2 26 April 2001 (26.04.2001) GB  
60/345,661 2 January 2002 (02.01.2002) US

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(81) Designated States (national): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, OM, PH, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZM, ZW.

(84) Designated States (regional): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

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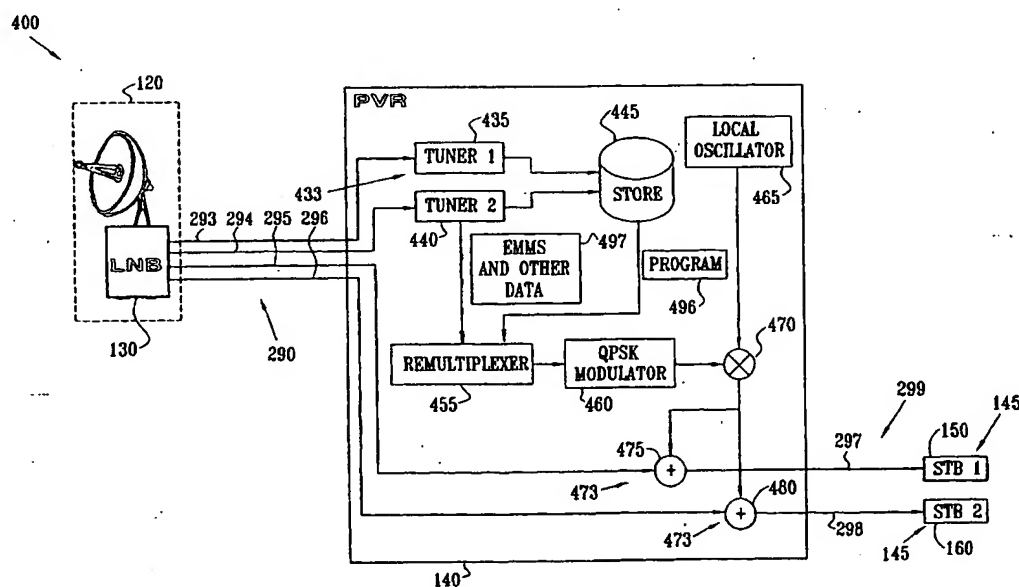
Published:

— with international search report

(88) Date of publication of the international search report:  
8 May 2003

[Continued on next page]

(54) Title: HOME NETWORK SYSTEM



(57) Abstract: An audio visual content server including a content storage unit operative to store audio and / or video content, a content transmission unit including a modulator and operative to receive digital signals including encoded audio and / or video content and to transmit modulated signals to at least one receiving device, and a tuner unit operative to: receive input signals including encoded audio and / or video content; and output the received signals to the content storage unit for storage therein, wherein the content transmission unit receives the signals at least from the content storage unit. Related apparatus and methods are also described.



*For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.*

## INTERNATIONAL SEARCH REPORT

Int. Application No.

PCT/IB 02/01359

A. CLASSIFICATION OF SUBJECT MATTER  
 IPC 7 H04N7/10 H04N7/173

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)  
 IPC 7 H04N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages.	Relevant to claim No.
X	WO 95 15658 A (DISCOVERY COMMUNICAT INC) 8 June 1995 (1995-06-08)	1,2, 8-16,38, 40-46,92
Y	page 14, line 8 - line 11 page 15, line 12 - line 21 page 15, line 1 - line 6 page 17, line 19 - line 27 page 26, line 8 - page 27, line 12; figure 4 figure 7 --- -/--	3

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

## \* Special categories of cited documents:

- \*A\* document defining the general state of the art which is not considered to be of particular relevance
- \*E\* earlier document but published on or after the international filing date
- \*L\* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- \*O\* document referring to an oral disclosure, use, exhibition or other means
- \*P\* document published prior to the international filing date but later than the priority date claimed

- \*T\* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- \*X\* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- \*Y\* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
- \*G\* document member of the same patent family

Date of the actual completion of the international search

20 September 2002

Date of mailing of the international search report

29. 01. 2003

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DOCKHORN H.S.

## INTERNATIONAL SEARCH REPORT

Int. Patent Application No.

PCT/IB 02/01359

## C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 00 72596 A (MARGULIS NEAL) 30 November 2000 (2000-11-30)  page 4, line 1 - line 13 page 5, line 3 - line 7 page 10, line 7 - line 17 page 14, line 4 - line 9 page 17, line 24 -page 18, line 12 ---	1,2, 8-16, 38-46,92
Y	US 6 052 384 A (HUANG ET AL) 18 April 2000 (2000-04-18) column 4, line 35 - line 48 ---	3
P,A	WO 01 30086 A (EXPANSE NETWORKS INC ;HAMILTON JEFFREY S (US)) 26 April 2001 (2001-04-26) page 10, line 8 - line 14 -----	3

# INTERNATIONAL SEARCH REPORT

national application No.  
PCT/IB 02/01359

## Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:  
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☐ Claims Nos.:  
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:
3. ☐ Claims Nos.:  
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

## Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

1-47, 92

### Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest.
- ☐ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM . PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. Claims: 1-3, 4-7 (on 3), 8-13 (on any of 1-3),  
14-18 (on 3), 19-37 (on 3), 38-46 (on any of 1-3),  
47 (on 3), 92 (on any of 1-3)

Piecewise linear remultiplexer

2. Claims: 4-7 (on 1 or 2), 8-47 (on any of 4-7 (on 1 or 2)),  
92 (on any of 4-7 (on 1 or 2))

Digital modulator

3. Claims: 14-18 (on 1 or 2),  
19-47 (on any of 14-18 (on 1 or 2)), 48-91,  
92 (on any of 14-18 (on 1 or 2))

Control data

4. Claims: 19-37 (on 1 or 2),  
38-47 (on any of 19-37 (on 1 or 2)),  
92 (on any of 19-37 (on 1 or 2))

Set top box

5. Claims: 47 (on 1 or 2), 92 (on 47 (on 1 or 2))

Low noise block



# INTERNATIONAL SEARCH REPORT

formation on patent family members

Int. Application No

PCT/IB 02/01359

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